NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

ARMY RESERVE TRAINING SEAT ALLOCATION MODEL

by

Sylvester H. Brown

June 2002

Thesis Advisor: David Olwell
Second Reader: Samuel E. Buttrey

Approved for public release; distribution is limited

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** June 2002	**3. REPORT TYPE AND DATES COVERED** Master's Thesis

4. TITLE AND SUBTITLE: Army Reserve Training Seat Allocation Model	**5. FUNDING NUMBERS**
6. AUTHOR(S) Brown, Sylvester H.	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) Personnel Division, Office of the Chief, Army Reserve Arlington, VA	**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	**12b. DISTRIBUTION CODE**

13. ABSTRACT *(maximum 200 words)*

This thesis reduces wasted Reserve training seats by one-fourth, improving resource use and increasing readiness. The Army Reserve currently uses approximately 80% of its scheduled Initial Entry Training seats each year (wasting over 3000 seats for soldiers assigned to Troop Program Units). Reasons include misalignment of Basic Combat Training with follow-on Advanced Individual Training, scheduling too many seats during a period when targeted trainees are not available for training, and limited training capacity for specific specialties that units require for improved readiness. The Office of the Chief, Army Reserve Personnel Division negotiates with other Army components in the Training Resource Arbitration Panel to make adjustments to schedules of the Army Training Requirements and Resources System. Input from Recruiting Command and expert judgment is inadequate. This thesis allocates Army Reserve seats among competing needs of Army components and within available resources to increase seat utilization, thus increasing readiness. We validate the model by comparing historical training with model results and use these results to establish feasible training schedules to meet future goals and respond to readiness, recruiting and retention in the Army Reserve. This model provides a Reserve training schedule for FY 03 that optimally allocates funded training resources to improve unit readiness, achieves fiscal year goals established by the Structure Manning Decision Review, and eliminates mismatches between basic and advanced training that caused lost training resources in the past. The Army Reserve can set various goals and establish a schedule that remains responsive to historical starts. When specialty readiness prioritization occurs, users will simply establish weights for these priorities as part of the input data. This model requires data inputs from the Army Training Requirements and Resources System and the Total Army Personnel Database - Reserve. We expect a reduction in training seat loss from 20% to approximately 15%. This means that over 15,000 Reserve soldiers will become specialty qualified during FY 03 versus 13,000, improving readiness in Troop Program Units. The Personnel Division should implement this model to help in the Training Resource Arbitration Panel process.

14. SUBJECT TERMS Optimization, Linear Programming, GAMS, Operations Research, Scheduling, Training	**15. NUMBER OF PAGES** 105
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

ARMY RESERVE TRAINING SEAT ALLOCATION MODEL

Sylvester H. Brown
Major, United States Army Reserve
B.S., Georgia Southern College, 1985
M.A., Webster University, 1994

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
June 2002

Author: Sylvester H. Brown

Approved by: David Olwell
Thesis Advisor

Sam Buttrey
Second Reader/Co-Advisor

James N. Eagle
Chairman, Department of Operations Research

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

This thesis reduces wasted Reserve training seats by one-fourth, improving resource use and increasing readiness. The Army Reserve currently uses approximately 80% of its scheduled Initial Entry Training seats each year (wasting over 3000 seats for soldiers assigned to Troop Program Units). Reasons include misalignment of Basic Combat Training with follow-on Advanced Individual Training, scheduling too many seats during a period when targeted trainees are not available for training, and limited training capacity for specific specialties that units require for improved readiness.

The Office of the Chief, Army Reserve Personnel Division negotiates with other Army components in the Training Resource Arbitration Panel to make adjustments to schedules of the Army Training Requirements and Resources System. Input from Recruiting Command and expert judgment is inadequate.

This thesis allocates Army Reserve seats among competing needs of Army components and within available resources to increase seat utilization, thus increasing readiness. We validate the model by comparing historical training with model results and use these results to establish feasible training schedules to meet future goals and respond to readiness, recruiting and retention in the Army Reserve. This model provides a Reserve training schedule for FY 03 that optimally allocates funded training resources to improve unit readiness, achieves fiscal year goals established by the Structure Manning Decision Review, and eliminates mismatches between basic and advanced training that caused lost training resources in the past. The Army Reserve can set various goals and establish a schedule that remains responsive to historical starts. When specialty readiness prioritization occurs, users simply establish weights for these priorities as part of the input data. This model requires data inputs from the Army Training Resources and Requirements System and the Total Army Personnel Database - Reserve.

We expect a reduction in training seat loss from 20% to approximately 15%. This means that over 15,000 Reserve soldiers will become Specialty Qualified during FY 03 versus 13,000, improving readiness in Troop Program Units. The Personnel Division should implement this model to help in the Training Resources Arbitration Panel process.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

O GIVE thanks unto the Lord; for he is good: for his mercy endureth for ever. (Psalm 136:1 – KJV).

Thank you to my thesis advisor, Senior Lecturer David Olwell, for sharing his insights, time and resources to make this thesis a useful and presentable product. Thank you for your expertise and patience.

Thanks to my second reader, Professor Samuel E. Buttrey for his diligence and time to make sure this thesis is a presentable product.

I especially thank Distinguished Professor Gerald Brown for his dedication and selfless service. He spent long hours in the formulation and implementation of my model. He overcame my ignorance with knowledge, my inability to communicate with a lexicon, and my late-night Emails with perseverance. He is an example of God's goodness and mercy toward me. Thank you very much Professor Brown!

Thanks to LTC Frank Willingham, LTC Stewart Goesch, MAJ Ward Litzenberg and MAJ Tom Rahe of OCAR, Personnel Division and MAJ Rick Morrison of Recruiting Command, Recruiting Operations for their support, time and insights about the problems pertaining to this thesis.

Thank you to Mrs. Kathy Aceto of OCAR, Personnel Division, Mr. Alan Craig of ODCSPER, MPT and Mr. Tom Patrick of TRADOC, TOMA for providing the data needed for this model. They took the time to write and run queries, download and manipulate data, and explain what the data meant. I could not have built this model without your assistance.

I especially thank LTC Gene Paulo of TRAC, Monterey for funding my experience tour for data collection and research.

To the finest lady in the universe (my wife Denise), I owe my gratitude and appreciation for her steadfast support, encouragement and strength to maintain and care

for our boys (Jonathan and Joseph). Thank you for your assuring confidence, continual prayers and inspiring love throughout this process.

LIST OF ACRONYMS

AC	Active Component
AIT	Advanced Individual Training
AR	Army Regulation
ARM-R	Automated Requirements Model - Reserve
ARNG	Army National Guard
AR-PERSCOM	Army Reserve Personnel Command
ARPRINT	Army Program for Individual Training
ATRRS	Army Training Requirements and Resources System
BCT	Basic Combat Training
DMOSQ	Duty Military Occupational Specialty Qualified
FY	Fiscal Year
GAMS	General Algebraic Modeling System
HQDA	Headquarters, Department of the Army
IET	Initial Entry Training (OSUT or BCT/AIT or SP1/SP2)
LP	Linear Program
MIP	Mixed Integer Program
MOS	Military Occupational Specialty
NGB	National Guard Bureau
NPS	Non-Prior Service
NT	No Training
OCAR	Office of the Chief, Army Reserve
ODCSOPS	Office of the Deputy Chief of Staff for Operations and Plans
ODCSPER	Office of the Deputy Chief of Staff for Personnel
OSUT	One Station Unit Training (Combined BCT and AIT)
POM	Program Objective Memorandum
PS	Prior Service
REQUEST	Recruit Quota System
SMDR	Structure Manning Decision Review

STO1 (SP1)	Split Training Option 1 (BCT)
STO2 (SP2)	Split Training Option 2 (AIT)
TOMA	Training Operations and Management Analysis Division of TRADOC
TAPDB-R	Total Army Personnel Database - Reserve
TRADOC	U.S. Army Training and Doctrine Command
TRAP	Training Resource Arbitration Panel
USAR	United States Army Reserve
USAREC	U.S. Army Recruiting Command

DEFINITION OF TERMS

Seats	Available capacity to train for a course starting in a given week.
Starts	Number of actual trainees expected to start training in a given week.
Trainee	A student in some phase of Initial Entry Training (IET).
Week	A seven-day period designated by the Monday of that week. A start occurs in a particular week if training begins Monday through Friday of that week.
He (his, him)	generalized masculine term denoting both male and female.

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

This thesis reduces wasted Reserve training seats by one-fourth, improving resource use and increasing readiness. The Army Reserve currently uses approximately 80% of its scheduled Initial Entry Training (IET) seats each year. This means that the Army Reserve wastes over 3000 funded training opportunities for soldiers assigned to Troop Program Units (TPU). Factors contributing to the loss of these training opportunities include (1) misalignment of Basic Combat Training (BCT) with follow-on Advanced Individual Training (AIT), (2) scheduling too many seats during a period when the targeted trainees are not available for training and (3) limited training capacity for specific Military Occupational Specialties that TPUs need to improve readiness.

The Office of the Chief, Army Reserve (OCAR) Personnel Division is responsible for acquiring IET seats to meet Army Reserve personnel readiness needs. Personnel Division participates in the Training Resource Arbitration Panel (TRAP) to make adjustments to schedules of the Army Training Requirements and Resources System (ATRRS). In the negotiating process with the other Army components (Active Army and Army National Guard), Personnel Division relies on input from Recruiting Command and expert judgment. These inputs are sensitive to recruiting success with minimal consideration for Army Reserve personnel readiness.

The objective of this thesis is to allocate Army Reserve IET seats among competing needs of the other two components and within available resources to increase seat utilization. Consequently, if more IET seats are filled, more soldiers in a TPU will obtain duty qualification in their military specialty, thus increasing readiness. We validate the model by comparing historical starts with model results. Once validated, we use this model to establish feasible IET schedules to meet future goals that respond to readiness, recruiting and retention in the Army Reserve.

This model provides an IET schedule for FY 03 for the Army Reserve that optimally allocates funded training resources to improve TPU readiness. The model uses goal programming to achieve fiscal year MOS goals established by the Structure Manning Decision Review. It eliminates mismatches between BCT and AIT that caused

lost training resources in the past. This model takes into account historical utilization of IET seats as a parameter in establishing FY 03 starts. This approach enables the Army Reserve to set various goals for the planning year and establish a schedule that remains responsive to historical starts.

This model will easily accommodate policy changes and additional constraints. As the Army Reserve negotiates during the Training Resource Arbitration Panel, we can input constraints stipulated through negotiations and determine the effect of these additional limitations and the resulting schedule changes. If MOS readiness prioritization within the Army Reserve occurs, we will simply adjust weights for these priorities as part of the input data.

This model requires data inputs from ATRRS and TAPDB-R. The Army Reserve must download files from these databases and manipulate the information in spreadsheets for proper formatting as "include" files in the Army Reserve Training Seat Allocation Model.

We expect a reduction in IET seat loss from twenty percent (20%) to approximately fifteen percent (15%). This increase in utilization is due to placement of seats in accordance with historical use, MOS seat availability, and the linkage of BCT to AIT. This means that over 15,000 Reserve soldiers will become duty Military Occupational Specialty qualified during FY 03, improving readiness in TPUs. In previous years, fewer than 13,000 Reserve soldiers became DMOSQ in a given year.

The OCAR, Personnel Division should implement this model to help in the TRAP process. Personnel Division already has the General Algebraic Modeling System and CPLEX solver needed to implement this model. Personnel Division should request reports from ATRRS and TAPDB-R that will easily accommodate the format of input data to the model. Alternately, Personnel Division may import raw data to EXCEL or some other data manipulation software to create input data files for the model. This would be a powerful tool to adjust shortcomings found in ATRRS and validate any additional applications that resource and schedule IET seats.

I. INTRODUCTION

This thesis improves the scheduling of Initial Entry Training (IET) seats for the Army Reserve, thus increasing readiness. The Army Reserve currently uses approximately eighty percent of their scheduled IET seats each year. This means that the Army Reserve loses over 3000 funded training opportunities for soldiers assigned to Troop Program Units (TPU). A new recruit becomes a member of a TPU as soon as he signs the enlistment contract, but he is not qualified to perform his military specialty duties until after IET training is complete. This new recruit counts for assignment but does not count as duty qualified, impacting the unit's overall readiness rating and posture for deployment.

A TPU is any Reserve unit that drills one weekend a month and one two-week period per year. The size of a TPU ranges from a detachment as small as 10 people to a battalion of several hundred troops. Brigade-sized units and above are made up of several subordinate TPUs.

To become duty qualified for a military specialty, Army Reserve new recruits must attend Basic Combat Training (BCT) followed by Advanced Individual Training (AIT). These recruits train along with new recruits of the other Army components: the Active Army and the Army National Guard. The Total Army has a few alternate training programs to accommodate the need of all three components: One Station Unit Training and Split Training Options. These training programs are explained below.

The objective of this thesis is to allocate Army Reserve IET seats among competing needs of the other two components and within available resources to increase seat utilization. Consequently, if more IET seats are filled, more soldiers in a TPU will obtain duty qualification in their military specialty, thus increasing readiness. We will validate the model by comparing historical starts with model results. Once validated, we will use this model to establish feasible IET schedules to meet future goals that respond to readiness, recruiting and retention in the Army Reserve.

A. BACKGROUND

Each year, the three Army components (Active Army, Army Reserve and Army National Guard) coordinate the allocation of IET seats for the coming fiscal year. The Army Reserve currently uses input from the United States Army Recruiting Command (USAREC) and expert judgment to determine its seat requests and negotiating strategy.

In FY 2000, the Office of the Chief, Army Reserve (OCAR) Personnel Division acquired the task of determining and arbitrating IET seat requirements for the Army Reserve. The Personnel Division programs and coordinates IET resources in support of personnel requirements to maintain TPU combat readiness. Presently, it forecasts yearly IET training requirements through the Structure Manning Decision Review (SMDR).

The SMDR states requirements in terms of the total number of individuals needed to train by military specialty by fiscal year. After OCAR and the other Army components determine training requirements, the United States Army Training and Doctrine Command (TRADOC) plans, schedules and provides resources for training to meet established requirements for all three Army components (TRADOC Reg 350-6). The Training and Doctrine Command establishes the training schedule with the primary program of training composed of two phases: BCT and AIT. However, there are a few alternate training programs available. We discuss IET composition in the following paragraphs.

1. Basic Combat Training

The first phase, BCT, provides training for skills that all soldiers must possess to increase survivability and confidence in combat. It does not concentrate on any military specialty. Basic Combat Training is offered at five schools. Fort Benning, Fort Sill, and Fort Knox train only males for BCT, while Fort Jackson and Fort Leonard Wood train both males and females. All first-time trainees must enter through one of these installations. The Training and Doctrine Command conducts all BCT for the Army. The length of BCT is nine weeks.

2. Advanced Individual Training

The second phase, Advanced Individual Training, trains individuals for their military specialty. The Army Reserve currently has approximately 160 Military Occupational Specialties (MOS) that train at approximately 60 schools. Most schools are run by TRADOC but some trainees attend schools run by the Navy and Air Force. Trainees normally attend AIT immediately after completion of BCT. Some trainees experience a delay in starting AIT due to over-scheduling by training managers. The length of AIT varies by MOS from four weeks to 46 weeks.

3. Alternate Training Programs

Alternate training programs include One Station Unit Training (OSUT) and the Split Training Option (SPO). Both training programs involve selected MOS and schools.

One Station Unit Training is a training program composed of a training class of trainees who undergo both BCT and AIT sequentially as a unit. Each class of trainees has the same MOS – usually the high volume combat arms skills. Four schools offer OSUT as follows.

School	Location	MOS
s804	Fort Knox	19D1, 19K1 (Armor)
s807	Fort Leonard Wood	12B1, 12C1, 54B1, 95B1, 95C1
		(Engineer, Chemical, Military Police)
s809	Fort Benning	11B1, 11C1, 11H1, 11M1 (Infantry)
s810	Fort Sill	13B1 (Field Artillery)

Table 1. OSUT School Locations and MOS

The Split Training Option program allows Army Reserve and National Guard trainees to attend phase one training (BCT), exit training and reschedule to attend phase two training (AIT) three or more weeks later. The Army National Guard and Army Reserve use this training option primarily to recruit high school juniors. They send these

recruits to BCT during the summer recess between their junior and senior years and to AIT after graduation. The Reserve Components also use this option to train recruits who attend college or workers who experience seasonal layoffs, such as construction workers and farmers. All five BCT schools offer Split Training Option One (SP1) to a total of over 3500 participants. Selected AIT schools offer Split Training Option Two (SP2) in over 90 MOS each year. All OSUT schools and MOS offer Split Training Option One OSUT (SP1o) and Split Training Option Two OSUT (SP2o) except for 95C1.

B. CURRENT METHODS

The Army Reserve currently uses input from USAREC and expert judgment to determine its seat requests and negotiating strategy. This expert judgment is known to be inadequate and does not ask for the allocation that would best meet the Army Reserve needs. Therefore, the Army Reserve must adjust misalignments and shortfalls of training courses during each fiscal year. Secondly, the Army Reserve relies on the sister components having unfilled seats during the 45-day window before the training start date to remedy its lack of planned seats. Unfilled seats during this window become available to all components to schedule trainees and cannot be relied upon by the Army Reserve.

Figure 1 below shows the systematic identification of IET requirements and resources for the Army Reserve. The Automated Requirements Model–Reserve (ARM-R) is an automated program feature of the Army Training Requirements and Resources System (ATTRS) that uses input from the Total Army Personnel Database–Reserve (TAPDB-R) and ATTRS. The ARM-R is used during the Structure Manning Decision Review to generate the Army Program for Individual Training (ARPRINT) results. Training and Doctrine Command Proponent Schools use the ARPRINT results to determine class schedules for each school. The Office of the Deputy Chief of Staff for Personnel loads the ARPRINT results and TRADOC Proponent School Schedules into ATRRS. The Office of the Deputy Chief of Staff for Personnel uses ATRRS to manage quotas and implement scheduling of all IET resources.

The Office of the Chief, Army Reserve Personnel Division monitors scheduling and utilization of allocated IET. The U.S. Army Recruiting Command schedules training for new recruits through the Recruit Quota System (REQUEST) while Troop Program

Units schedule training through a connection to the ATRRS system directly. The Office of the Chief, Army Reserve Personnel Division adjusts IET allocation through the Training Resource Arbitration Panel (TRAP) process to try to meet projected shortfalls or overages for the current year and planning year.

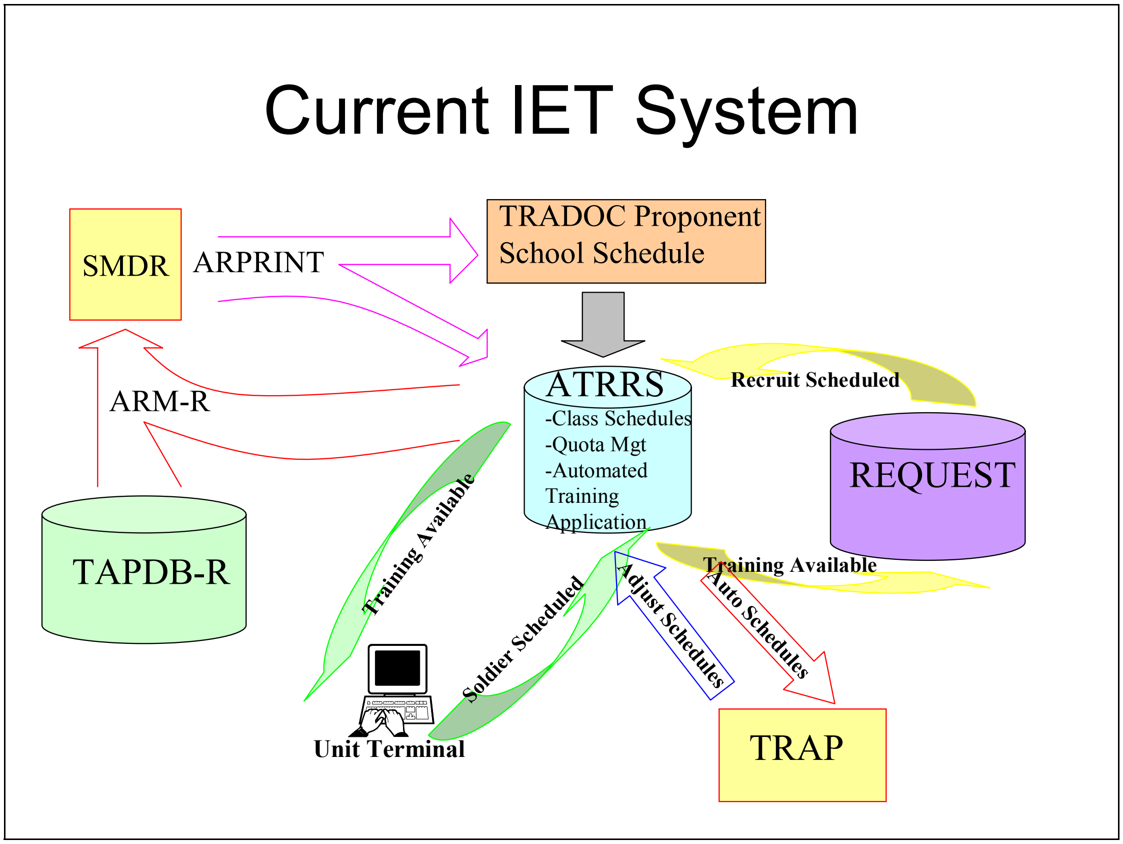

Figure 1. Current IET System
Systematic identification and activity flow for IET requirement. ATRRS is the central database in Army training management.

C. PROBLEM

1. What is the problem?

During the Training Resource Arbitration Panel, the Army Reserve relies on the input from USAREC and individual expert judgment to determine its seat requests and negotiating strategy. This expert judgment is known to be inadequate and does not ask for the allocation that would best meet the Army Reserve needs. The expert gives little consideration to military specialty shortfalls and readiness priority. The U. S. Army Recruiting Command provides input that simply gives them the best opportunity to successfully recruit individuals. Since the Army Reserve does not know the demand nor

what allocation would best meet its needs, it cannot request them. As a result, the Army Reserve negotiated solution accepts seats it cannot fill and does not provide seats when needed. This results in unused training seats, training shortfalls, crisis management of what should be a routine process, and wasted resources.

2. Why is the problem important?

The effects of poor allocation are large. The inability to match allocation of seats with demand is hampering the combat readiness of Army Reserve units. Approximately 5% of the soldiers assigned to Army Reserve billets are not trained for their military specialty as a consequence of being unable to obtain an IET seat during a preferred training period. Approximately 20% of Army Reserve IET seats go unused each year, resulting in a large waste of training resources. Because of inconsistent scheduling requests, trainees spend long periods in a "holding status" awaiting training. This reduces the trained end strength of the Army. If the Army Reserve knew its optimal allocation strategy, it could increase readiness and reduce resource losses. Knowing its optimal allocation strategy helps the Army Reserve determine the effects of accepting a non-optimal solution during the negotiating process and guide the coordination process to minimize deviation if the Army Reserve optimal solution was unacceptable to the other two components. Currently, the Army Reserve cannot determine the effect of accepting non-optimal IET seat allocations. The Army Reserve cannot predict unused seats, seat shortages, and amounts of hold-time nor compare such effects against a best-case allocation.

3. How will the problem be solved without this work?

ASM Research Inc. has proposed to build a model by FY03 which conducts the same function as the Army Reserve Training Seat Allocation Model (ARTSAM). The Office of the Chief, Army Reserve Personnel Division has recently used ASM Research Inc., a military contractor who maintains ATRRS, to develop and implement the ARM-R to generate ARPRINT results for FY03 and beyond (see Figure 1). Subsequently and in parallel to this work, ASM Research Inc. has proposed building another model to improve the TRAP process for the Army Reserve. Their model will be an extension of ATRRS that generates the current IET schedules. This option will incur development cost plus yearly maintenance and execution cost for the Army Reserve.

D. RELATED RESEARCH

Much research and analysis was done during the 1990s to improve efficiency in the Total Army School System. Many of these studies concentrated on matching training resources with training demand. Others attempted to minimize cost while meeting training demands with fewer training sites.

Hall (1999) created an optimization model to schedule enlisted IET courses. She used a mixed-integer program scheduling model for all BCT, OSUT and AIT courses for the Total Army. Her primary objective was to minimize the annual soldier training requirements not met and optimally fill courses. She utilized a series of balance flow equations to match demand with available resources while minimizing the number of new recruits held over. She predicted a 50% reduction in unmet training demand by using her automated model compared to the current system of manual input by experts. She also expected to use 5500 seats that would otherwise become lost training opportunities due to inefficient scheduling. Army training managers may use her model for planning the FY 04 training schedule.

RAND conducted a two-year study, Winkler, et al. (1999), on the feasibility of establishing the Total Army School System, a regional system of Reserve Component schools for Non-commissioned Officer education and reclassification training. RAND used basic statistics and systems analysis to conduct their research. Their recommendations included reducing student demand, improving forecasting methods for student demand, adjusting capacity, and making better use of available capacity by using the reservation system more efficiently – reducing the number of unused seats.

Most scheduling problems must address the fluctuation in demand by determining the best fit of resources available. These models often assume that the demand can be accurately forecasted by observing historical use. Whaley (2001) created an optimization model which reduces the unpredictable demand by extending the range of consideration for the trainee to include recruitment for enlisted Marines. He used two integer linear programs in his thesis. His first model would determine the input requirements and develop a schedule for training and recruitment for a two-year period. The second model takes the results from the first model and develops short-range adjustments to the long-

range schedule of the first model. If the Marine Corps Recruiting Command continually recruits within established recruiting maxima and minima, his model would reduce the total wait time of enlisted Marines from 2700 Marine-years to approximately 800 Marine-years.

II. MODEL

A. PROBLEM DEFINITION

The current system of automatically scheduling Army Reserve IET seats in ATRRS requires adjustment. Using USAREC input and expert judgment to determine adjustments is known to be inadequate and does not ask for the allocation that would best meet the Army Reserve needs. We need to determine and request a Army Reserve negotiated solution through a routine process that improves seat utilization, reducing wasted resources.

1. Training Seat Utilization

With the current system, the Army Reserve uses approximately 80% of its scheduled training resources for IET. One contributing factor is the limitations on input to training levels. Training managers allot IET seats above expected input to training trends for the first quarter and below expected input to training trends for the third quarter of each year. Many users of these seats, new recruits, join the Army Reserve while in high school and must wait until the summer recess to attend training. Another target market for recruiting, college students, presents the same situation.

Some of this inefficient scheduling is a consequence of reality. The training base, as designed, cannot expand and contract beyond a certain degree. Thus, many funded and allocated training opportunities are lost.

Another factor is the misalignment of BCT seats to follow-on AIT seats. Before a counselor can assign a training seat with a start date to a recruit, he uses the Recruit Quota System to interface with ATRRS to determine the availability of BCT and follow-on AIT. If either BCT or AIT is not available within the allowable parameters, the counselor cannot assign any available seat to the recruit. This policy does not apply to alternate training program participants. There are times when BCT is available while AIT is not and vice versa. Thus, many training opportunities are lost.

2. Training Type and MOS Prioritization

The Army Reserve does not link IET seat allocation proposals to military specialty shortages or priorities. At present, limited Army Reserve IET seats by class and military specialty are not optimally allocated to the Army Reserve based on current or projected personnel shortfalls and readiness priorities. Current TRAP adjustments are based on recruiting results. Therefore, as long as positions are available for easy selling military specialties, the Army Reserve will request more seats in these specialties at the recommendation of USAREC. This approach neglects the need to address military specialties with greater personnel shortages or mission priorities.

3. Modeling Approach

The following model of Army Reserve basic and advanced training is expressed in terms of a lexicon that has precise meaning[1]. This is a periodic review model of a continuously operating nationwide training system. The planning horizon is one fiscal year, some constraints are imposed monthly, and the finest time resolution is a ***week***. We express capacity to train in terms of "***seats***" available for a syllabus at a ***school*** starting in a given week, while determining training activity in terms of the number of actual "***starts***" that we decide to put in some of those seats. Each training syllabus has a duration expressed in weeks. The transition from initial to advanced training may involve a planned delay, or ***hold*** period, and may admit moving from one school to another. Because we express decisions in terms of syllabus starts, assessing related quantities that may be constrained requires some indirect computation. For instance, a student start one week implies a contiguous set of succeeding weeks in training. So if we need to count all "***trainees***" in training during some particular month, we must sum over all weeks in that month. For each of those weeks we determine how many starts are still in training, while taking care not to count any particular start more than once during the month. The objective of this planning is to adhere to a set of potentially conflicting planning goals that recommend levels of activity over the planning horizon.

[1] Distinguished Professor Gerald Brown contributed significantly to the model definition and formulation.

B. ASSUMPTIONS

- Split Option trainees are given priority in filling BCT courses.
- SP1 trainees will attend training during May, June, and July only.
- Split Option trainees will only attend one phase of training during the planning horizon, i.e., attend SP1 training with expectations to return the next fiscal year or return to SP2 training only.
- Split Option training is applicable to every MOS.
- Trainees who are recycled do not count twice against Initial Entry Training (IET) seat allocations and in accordance with AR 350-10 (1990) are not tracked separately in attrition calculations.
- IET applies to soldiers in grade E-1 through E-4 only.
- The attrition rate for phase one trainees is six (male only training) to seven percent (co-ed training).
- Recruiting and shipment to training will increase due to Recruiting Command's focus on the non-prior service (NPS) market and the increase in the number of funded reserve seats from 18,000 to 19,000.
- The Army Reserve will be able to achieve at least 90% of the highest historical starts for each month and type seat.

C. INDICES

Index use (~cardinality)

t^- initial training type including BCT, OSUT1, SP1, and SP1o

t^+ advanced training type including AIT, OSUT2, SP2 and SP2o

t $t^- + t^+$, all training types

$t^+(t^-)$ advanced training type t^+ that follows initial training type t^-

i.e., AIT(BCT), OSUT2(OSUT1), SP2(SP1), SP2o(SP1o)

$t^{-}(t^{+})$ initial training type t^{-} that precedes advanced training type t^{+}

i.e., BCT(AIT), OSUT1(OSUT2), SP1(SP2), SP1o(SP2o)

Ω includes $t^{+}(t^{-})$ where t^{-} begins before planning horizon and $t^{-}(t^{+})$

where t^{+} begins after the planning horizon

w planning week in planning horizon (=wfirst,…,wlast) (~50)

m planning month in planning horizon (~12)

$\{w\}_m$ set of planning weeks in planning month m (~4-5)

h number of weeks that a trainee is held between completing initial training and starting advanced training during the planning horizon (~0-5)

$\{h\}_{t^{+}}$ range of number of weeks a trainee may be held between completing initial and starting advanced training type t^{+} during planning horizon

n MOS (~160)

s school (~24)

It is understood that not all combinations of indices are admissible. In particular, the 4-tuple (t,w,n,s) exhibits restrictions.

D. DATA

1. Given Data [units in brackets]

$goaltmn_{t,m,n}$ goal for Army Reserve initial training starts with MOS known, by type t, planning month m, and MOS n [starts]

$goaltm_{t,m}$ goal for Army Reserve initial training starts with no MOS known, by type t, and month m [starts]

$goalm_m$ training goal for month m [starts]

$goaln_n$	Army Reserve planning horizon goal for MOS *n*, expressed as the total number of students who have started advanced training during the planning horizon [MOS starts]
fymaxgoal	maximum number of funded Army Reserve starts in the planning horizon [starts]

Note: each goal instance within each type of goal is optional.

$seatstws^*_{t,w,s}$	capacity for starts of type *t*, in week *w* at school *s* [seats]
$seatstwns^*_{t,w,n,s}$	capacity for starts of type *t*, by week *w*, MOS *n* , at school *s* [seats]
$usar\_frac\_mx_{t,w}$	maximum Army Reserve fraction of each type *t* in week *w* [starts/seat]
$usar\_frac\_max_{t,w,n}$	maximum Army Reserve fraction of each type *t* by MOS *n* in week *w* [starts/seat]
$weeks_t$	course duration for course type *t* [weeks]
$attrit_s$	training attrition at school *s* [fraction of starts that graduate]
$pengoal_n$	penalty for violating $goaln_n$ [$/start]
penfymaxgoal	penalty for exceeding *fymaxgoal* [$/initial_start]
penunder	penalty per unit violation below any goal
nopen	fraction of surplus above goal allowed without penalty
nogoal	maximum number of allowable starts for any MOS with a goal of zero for the planning horizon

2. Derived Data

$seatstws_{t,w,s} \equiv usar\_frac\_mx_{t,w} \bullet seatstws^{*}_{t,w,s} \qquad \forall t, w, s$

establish Army Reserve seat capacity by type, week and school

$seatstwns_{t,w,n,s} \equiv usar\_frac\_max_{t,w,n} \bullet seatstwns^{*}_{t,w,n,s} \qquad \forall t, w, n, s$

establish Army Reserve seat capacity by type, week, MOS, and school

E. VARIABLES

1. Decision Variables [units in brackets]

$STARTR_{t,w,n,s}$ number of Army Reserve student starts of type t, week w, MOS n, and school s [starts]

$HOLDR_{t^{+},w,,h,n,s}$ number of Army Reserve students ready for advanced training type t^{+} starting a hold period in week w for h weeks, MOS n, school s [starts]

2. Elastic Goal Variables [units in brackets]

$UGOAL_{t,m,n}, OGOAL_{t,m,n}$ student starts respectively less than or exceeding $goaltmn_{t,m,n}$ [starts]

$SURPLUS_{t,m,n}$ excess student starts (at most $nopen \bullet goaltmn_{t,m,n}$) above $goaltmn_{t,m,n}$ without penalty [starts]

$UGOAL_{t,m}, OGOAL_{t,m}$ student starts deviating from $goaltm_{t,m}$ [starts]

$SURPLUS_{t,m}$ excess student starts (at most $nopen \bullet goaltm_{t,m}$) above $goaltm_{t,m}$ without penalty [starts]

$UGOAL_{m}, OGOAL_{m}$ student starts deviating from $goalm_{m}$ [starts]

$SURPLUS_m$ excess student starts (at most $nopen \bullet goalm_m$) above $goalm_m$ without penalty [starts]

$UGOAL_n$, $OGOAL_n$ student starts deviating from $goaln_n$ [starts]

$SURPLUS_n$ excess student starts (at most $nopen \bullet goaln_n$) above $goaln_n$ without penalty [starts]

$UGOAL, OGOAL$ student starts deviating from *fymaxgoal* [initial starts]

F. FORMULATION

1. Objective Function

$$\min \sum_{t,m,n} penunder \bullet UGOAL_{t,m,n} + OGOAL_{t,m,n}$$

$$+ \sum_{t,m} penunder \bullet UGOAL_{t,m} + OGOAL_{t,m}$$

$$+ \sum_{m} penunder \bullet UGOAL_{m} + OGOAL_{m}$$

$$+ \sum_{n} pengoal_n \bullet (penunder \bullet UGOAL_{n} + OGOAL_{n})$$

$$+ penfymaxgoal \bullet (OGOAL) \tag{2.1}$$

The objective function evaluates deviations from goals in constraints (2.8-2.16), converting any violations into common penalty units (e.g. $). This is a weight-average linear goal program.

2. Constraints

$$\text{st:} \quad \sum_{n} STARTR_{t,w,n,s} \le seatstws_{t,w,s} \qquad \forall t, w, s \tag{2.2}$$

$$STARTR_{t,w,n,s} \le \min(seatstws_{t,w,s}, seatstwns_{t,w,n,s}) \qquad \forall t, w, n, s \tag{2.3}$$

$$\sum_{t \in (AIT, SP2), s} STARTR_{t,w,n,s} \le \sum_{t \in AIT, s} seatstwns_{t,w,n,s} \qquad \forall w, n \tag{2.4}$$

$$\sum_{s}(1-attrit_{s})\cdot STARTR_{t^{-},w,n,s} = \sum_{s} STARTR_{t^{+}(t^{-}),w+weeks_{t^{-},n,s},n,s}$$

$$+ \sum_{s,\{h\}_{t^{+}(t^{-})}} HOLDR_{t^{+}(t^{-}),w+weeks_{t^{-},n,s},h,n,s}$$

$$\forall t^{-} \mid t^{+}(t^{-}) \in \{BCT, OSUT1\} \neq \Omega, w, n \qquad (2.5)$$

$$\sum_{s} STARTR_{t^{+},w,n,s} = \sum_{s}(1-attrit_{s})\cdot STARTR_{t^{-}(t^{+}),w-weeks_{t^{-}(t^{+}),n,s},n,s}$$

$$+ \sum_{s,\{h\}_{t^{+}}} HOLDR_{t^{+},w-h,h,n,s} \quad \forall t^{+} \mid t^{-}(t^{+}) \in \{AIT, OSUT2\} \neq \Omega, w, n \qquad (2.6)$$

$$\sum_{w,s} STARTR_{t^{-},w,n,s} \geq 1.05 \cdot \sum_{w,s} STARTR_{t^{+}(t^{-}),w,n,s} \qquad \forall t^{-} \mid t^{+}(t^{-}), n \qquad (2.7)$$

$$\sum_{\{w\}_{m},s} STARTR_{t,w,n,s} = goaltmn_{t,m,n}$$

$$- \, UGOAL_{t,m,n} + OGOAL_{t,m,n} + SURPLUS_{t,m,n} \quad \forall t, m, n \qquad (2.8)$$

$$SURPLUS_{t,m,n} \leq nopen \cdot goaltmn_{t,m,n} \qquad \forall t, m, n \qquad (2.9)$$

$$\sum_{\{w\}_{m},n,s} STARTR_{t,w,n,s} = goaltm_{t,m} - UGOAL_{t,m} + OGOAL_{t,m} + SURPLUS_{t,m}$$

$$\forall t, m \qquad (2.10)$$

$$SURPLUS_{t,m} \leq nopen \cdot goaltm_{t,m} \qquad \forall t, m \qquad (2.11)$$

$$\sum_{t,\{w\}_{m},n,s} STARTR_{t,w,n,s} = goalm_{m} - UGOAL_{m} + OGOAL_{m} + SURPLUS_{m} \quad \forall m \qquad (2.12)$$

$$SURPLUS_{m} \leq nopen \cdot goalm_{m} \qquad \forall m \qquad (2.13)$$

$$\sum_{t,w,s} STARTR_{t,w,n,s} = goaln_{n} - UGOAL_{n} + OGOAL_{n} + SURPLUS_{n} \qquad \forall n \qquad (2.14)$$

$$SURPLUS_{n} \leq nopen \cdot goaln_{n} \qquad \forall n \qquad (2.15)$$

$$\sum_{t^-,w,n,s} STARTR_{t^-,w,n,s} = fymaxgoal - UGOAL + OGOAL \qquad (2.16)$$

$$\sum_{t,w,s} STARTR_{t,w,n,s} \le nogoal \qquad \forall n \in \{goaln_n = 0\} \qquad (2.17)$$

(All variables continuous and nonnegative.)

Constraints (2.2) and simple upper bounds (2.3) limit Army Reserve starts to a maximum fraction of available training seats for the Army Reserve. Constraints (2.4) limit AIT and SP2 starts to a maximum of the available reserve AIT seats. Constraints (2.5) account for initial training graduates, who either begin advanced training immediately, or hold to begin advanced training later. Constraints (2.6) require that advanced training starts are either fresh graduates of initial training, or are returning from a hold between initial and advanced training. Constraints (2.7) ensure adequate initial training starts to accommodate advance training starts by MOS *n*. Constraints (2.8-2.16) stipulate goals and maximum allowable surplus exceeding these goals for training starts. The goals for constraints (2.16) are given in MOS starts (i.e., each trainee is counted at most once during the planning horizon). Simple upper bounds (2.17) limit the number starts for an MOS with a goal of zero and available seats.

Discretionary decisions during the planning horizon can be influenced by fixed exogenous decisions preceding the planning horizon, as well as by planning horizon goals. If we must link initial training starts for Army Reserve trainees engaged in BCT or OSUT1 prior to the planning horizon to subsequent advanced AIT or OSUT2 training during the planning horizon, we must specify weekly starts for the BCT and OSUT1 to account for any initial-to-advanced training holds for subsequent AIT or OSUT2. Because Army Reserve trainees in SPx training are released from duty between initial and advanced training, and because initial and advanced training are never started within a single planning horizon, we need only know the training goals for these starts during the planning horizon.

THIS PAGE INTENTIONALLY LEFT BLANK

III. DISCUSSION AND FINDINGS

A. DISCUSSION

1. Equations

The objective function of this model, equation 2.1, seeks to minimize the weighted value of deviation in expected starts versus goals. The objective function has an array of summation equations that may be excluded at the discretion of the user. These equations overlap in counting seat deviation. The user must determine which goals he or she wants to measure. If the user employs all summations simultaneously, results will reflect total overages and shortages by type, month and MOS; plus overages and shortages by type and month; plus overages and shortages by month; plus overages and shortages by MOS; plus overages and shortages by fiscal year. The penalties cause the units to change from seats to weighted values of seats.

Equation 2.2 limits the number of starts by type, by school and when applicable by MOS for each week. The Army Reserve allocation should not exceed a maximum fraction of the total seats available for a given week by type, school and MOS when applicable. The maximum fraction for Army Reserve allocation is 0.4 except during the summer period for BCT and OSUT1 or specific MOS. We reduce the maximum fraction to 0.35 during this period because of the high demand from the Active Army for BCT and OSUT1 seats. Specific MOS that have over 30% of their structure in the Army Reserve are assigned a maximum fraction ranging from 0.8 to 1.0.

Equation 2.3 accounts for initial training graduates who either begin advanced training immediately or hold to begin advanced training later. Phase two training at the beginning of the planning horizon (October through November) is not linked to phase one. Phase one training at the end of the planning horizon (August through September) is not linked to phase two training. This eliminates the need to schedule training outside the planning horizon while using established goals to dictate starts for these periods. Figure 2 below shows how the training phases link. The attrition and holds are incorporated to capture realistic events. The pairs considered in the model are BCT to AIT and OSUT1

to OSUT2. As stated earlier, OSUT1 and OSUT2 are one contiguous training event with some exceptions during the Christmas holiday period.

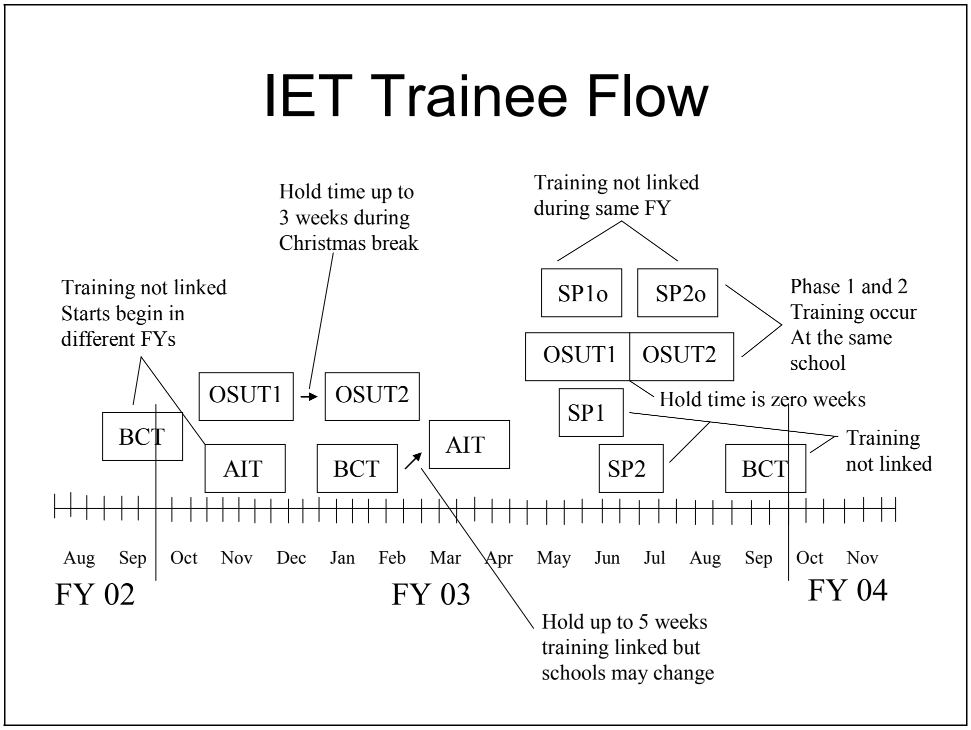

Figure 2. IET Trainee Flow
This figure show the initial-to-advance links during the planning horizon. No links exist between training sets that cross the planning horizon . No links exist between Split Training Options during the planning horizon.

Equation 2.4 requires that advanced training starts either be fresh graduates of initial training or be returning from a hold between initial and advanced training. Equations 2.3 and 2.4 maintain the flow balance of trainees who start both phases of training during the planning horizon. Equation 2.5a-d ensures that enough initial training starts occur to support advanced training starts by MOS *n* offset by weeks of training where applicable.

We model all split training independent of its complementing phase for the planning horizon, i.e., SP1 is not linked to any SP2 during the year and vice versa. Therefore, we do not consider any split training in this equation. We do not link BCT training to AIT if either starts outside the planning horizon. We do not link OSUT1 to OSUT2 if either starts outside the planning horizon. Therefore, AIT and OSUT2 training

that starts in October and November are not linked, and BCT and OSUT1 training that starts in August and September are not linked.

Equation 2.6 stipulates the goals for training by type and when applicable by MOS for a given month. The Office of the Deputy Chief of Staff for Personnel (ODCSPER) establishes and measures training goals by month while TRADOC actually start training classes by week. Weekly starts are associated with a month in accordance with the accession calendar of Recruiting Command. The variables $UGOAL_{t,m,n}$ and $OGOAL_{t,m,n}$ capture the shortage or overage of the established goals respectively. Goals are established by taking a five-year historical average of starts by type and MOS when applicable for a given month. $SURPLUS_{t,m,n}$ is optional with the maximum set as a percentage of the goaltmn$_{t,m,n}$.

Equation 2.7 stipulates the goals for training by type and month. This is a duplication of equation 2.6 with a lower level of resolution. Users may choose which equation to use based on information requirements. Equation 2.8 stipulates the goals for input to training by month only. This equation provides the lowest level of resolution for training requirements. The Office of the Chief, Army Reserve in coordination with ODCSPER set the policy for input to training goals (initial training starts). Equation 2.9 stipulates the goals for training by MOS only. The Office of the Chief, Army Reserve uses the SMDR process to establish MOS goals. Each trainee is counted at most once during the planning horizon.

Equation 2.10 stipulates the goals for training by fiscal year. It considers a penalty only for exceeding the maximum number of initial training starts for the fiscal year. Each trainee is counted only if he or she entered initial training during the planning horizon.

2. How does this thesis help?

This thesis and model provides the Army Reserve with a tool that generates a recommended schedule for available initial training resources. This schedule is derived from current resource limitations, historical starts, and current personnel readiness in the Army Reserve. During the annual arbitration meeting with sister components (Active Army and Army National Guard), the Army Reserve will be able to negotiate with

reference to an optimal solution. This optimal solution will both improve the Army Reserve's negotiating strategy and reduce crisis planning.

This model will help the Army Reserve conduct trade-off analyses at the start of each year and during adjustments throughout the year. Better planning will decrease the need for frequent current FY adjustments and ease reliance on sister components having unfilled seats that the Army Reserve can use.

Better planning improves readiness by increasing seat fill rates by minimizing unsuitable training seat dates for trainees. Although recruits may to some extent be motivated to attend training at the available times, the available training times must be feasible for the resource pool of recruits. For example, seniors in high school will not be available to attend training until late May through June at the earliest. It is poor practice to allot their seats earlier, but that is what, in fact, happens under the *status quo*.

This model also links Basic Combat Training starts minus attrition to Advanced Individual Training starts, reducing hold time and unfilled seats in subsequent courses.

Finally, this model weights the seat shortage penalties by military specialty to address the most pressing training needs. Critical shortages will be filled first as a result.

3. Scope of the thesis

This thesis builds and analyzes an optimization model for training seat allocation for the Army Reserve. The model uses the General Algebraic Modeling System (GAMS) to optimize the assignment of available training resources to meet identified training goals. The model considers training goals within the time schedules of the planning year. The model generates a recommendation of the number of seats by type, by military specialty, and by gender for each training week. For example, if the Army Reserve were allocated 1000 seats for military skill 88M1, the model would recommend how many seats to allocate to each week (available class start week) by gender. This model does not consider monetary incentives for training allocations. This model does not consider mobilization requirements.

B. INPUT DATA

The primary source for data was the ATRRS database. ATRRS provides historical data for starts for the past ten years. We averaged the historical starts from 1997 – 2001 to establish goals by type and MOS where applicable for a given month. We received data output from ATRRS by Social Security Number. We manipulated the data in a spreadsheet to compile by type of training, MOS, and school by training start date. We reconciled each training start date with the corresponding Monday of that week for each fiscal year. We then reconciled the weeks of each year to obtain an average starts for the corresponding training week in the planning horizon by the categories mentioned. It took approximately one week to prepare all the data for input into the model. For future data preparation, it should take approximately two days unless files are downloaded in a more appropriate format from ATRRS and TAPDB-R. Spreadsheet macros may reduce data preparation time by another 50%.

The ATRRS database also provides the available training capacity by type, MOS and school by training start date. We reconciled the training start dates with the corresponding training week for the planning horizon. Additional data from ATRRS include the mapping of schools and courses to training type and MOS when applicable. The course length and maximum, optimal and minimum class capacities are available.

The ATRRS database also maintains the SMDR results that stipulate the annual requirements by MOS and training type for the Army Reserve.

The Office of the Chief, Army Reserve, Personnel Division provides information on Army Reserve military specialty personnel fill, duty qualification and attrition rates. We reconciled these lists with the military specialty list maintained by ODCSPER to validate current military specialties in the model. These data points provide a basis for penalties by military specialty. The Personnel Division also provides the number of seats funded each fiscal year.

The Army Reserve does not know the readiness priority by military specialty at this time; however, they may incorporate this factor in the future to affect the penalty variables. We must limit the scale of the readiness priority penalties in relation to other

penalties for the model. If the readiness priority scale is too large, model results will be too sensitive to MOS goals versus other established goals.

Figure 3 below depicts the various data requirements for the model inputs.

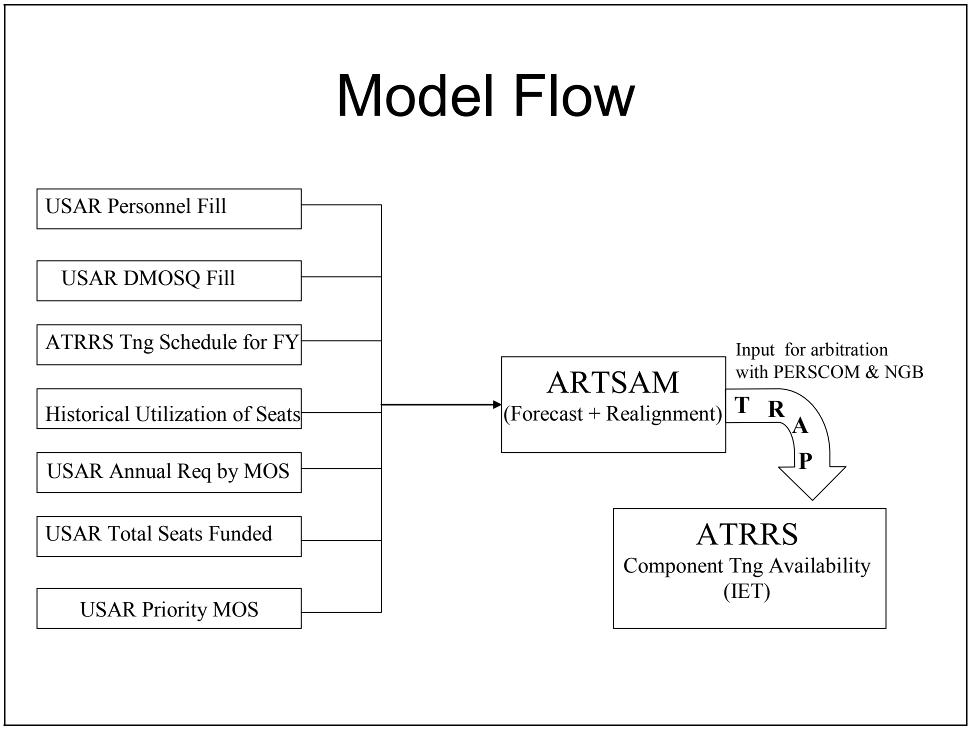

Figure 3. Input Model Flow

Figure 3 shows input data from various sources that the model uses to schedule IET training. Historical utilization of seats influences the distribution of training throughout the year within seat availability, training goals and priorities. The ARTSAM model is implemented during the TRAP and once results are approved, they are loaded into ATRRS.

1. MOS Penalty Inputs

We derive the MOS penalty by the following formula:

$Pengoal_n$ = (1 + ((1 - personnel fill %) + unit MOS attrition rate)

$\bullet$ (1-DMOSQ %)) $\bullet$ readiness Priority

If the personnel fill % and/or DMOSQ % is greater than or equal to 100% for a particular MOS, the formula is:

$Pengoal_n$ = 1 $\bullet$ readiness priority (readiness priority is greater than or equal to 1)

Since the readiness priority is not available, we give it a value of 1. Table 2 below is a sample of how the inputs for the MOS penalty are derived.

MOS	Required	Assigned	DMOSQ	Req Asgn %	Req DMOSQ %	Attrition	If[Asgn >= 100% or DMOSQ >= 100%,1, else 1 +((1-Asgn) + Attrit)*(1-DMOSQ)] *Rprior
11B	374	1031	542	275.7%	144.9%	48.1%	1.00
11C	138	69	33	50.0%	23.9%	46.1%	1.73
11H	51	51	29	100.0%	56.9%	40.8%	1.18
11M	533	111	58	20.8%	10.9%	64.4%	2.28
12B	2045	1551	1113	75.8%	54.4%	34.7%	1.27
12C	409	473	318	115.6%	77.8%	37.5%	1.00
13B	8	269	109	3362.5%	1362.5%	47.3%	1.00
13F	6	41	18	683.3%	300.0%	54.8%	1.00
13M	0	42	18	100.0%	100.0%	0.0%	1.00
19D	224	120	48	53.6%	21.4%	30.5%	1.60
19K	558	187	96	33.5%	17.2%	36.0%	1.85
25M	137	178	118	129.9%	86.1%	34.2%	1.00
25R	51	44	30	86.3%	58.8%	30.5%	1.18

Table 2. MOS Penalty Input

$Pengoal_n$ = [1 + ((1- Asgn %) + Attrition %) • (1- DMOSQ %)] • readiness priority. If Asgn % or DMOSQ % >= 100%, then $pengoal_n$ = 1 • readiness priority.

2. Other Penalties

Other penalties in the model are *penunder* and *penfymaxgoal*. *Penunder* is a general penalty for having fewer starts than the goal. The model has several elastic goals which conflict with each other. *UGOAL** violations are given more weight so as to overcome *OGOAL** violations. For example, historical utilization goals are met before SMDR stipulated MOS goals are achieved. The greater penalty for $UGOAL_n$ more than offset the penalty for $OGOAL_{t,m,n}$, allowing achievement of the MOS goals. The chart below depicts the utility of the general penalty. We will discuss the effect of penalty weights in the section on sensitivity analysis. Since exceeding the *fymaxgoal* for the fiscal year incurs additional cost we set a high penalty for *penfymaxgoal*. The arrows depict the pushing affect of the weights on training starts. If seats are available, the model will induce starts in accordance with the remaining goals. In the event a particular MOS goal is not met within the *fymaxgoal*, the *penfymaxgoal* will resist any additional initial training starts to fulfill that goal. Interested parties may view the results to

determine which goal are not met at the micro level of detail. We will discuss results in the next section.

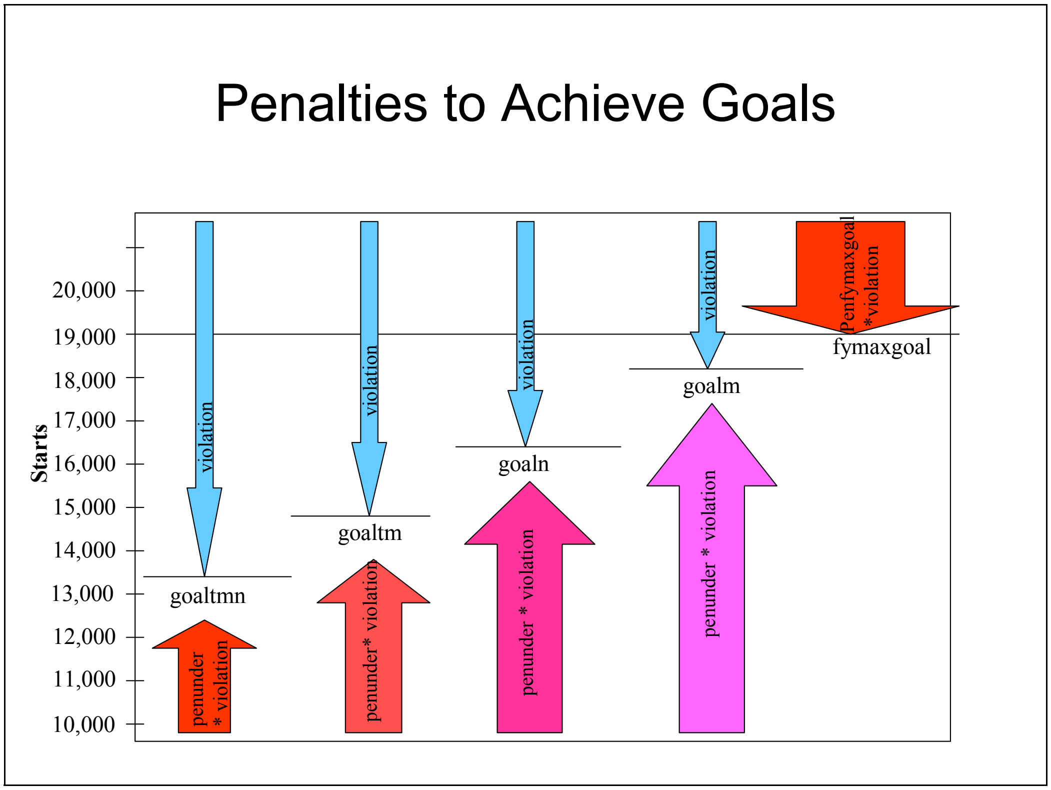

Figure 4. Penalties to Achieve Goals
Penunder = 5, *penfymaxgoal* = 10. The asymmetric penalties enable the model to achieve all feasible start goals at the expense of exceeding other goals. Therefore, all goals have greater penalties for under violations than over violations except for *fymaxgoal*, which does not have an under violation penalty.

C. RESULTS

Below we summarize the results from the model and compare results with the various goals established by Army Reserve funding, policy and historical use. During the Army Reserve Quarterly Update to the OCAR (4 May 2001), a USAREC analyst stated that the 5-year average number of initial training starts for the Army Reserve was 14,676 while funding approximately 18,000 seats. We received SMDR information by MOS from OCAR, Personnel Division that sums to approximately 17,000 while the seat funding level is 19,000 for FY 03. The following compares these varying goals with model results.

1. Historical Utilization Goals

In light of OCAR policy and various goals, we did not pursue a best fit model for historical utilization since the *status quo* is inadequate to meet the needs of the Army Reserve readiness demands. We used historical starts as an additional goal to influence the distribution of starts by type and MOS. The series of charts below depict the model results for FY 03 versus historical use from FY 97 through FY 01.

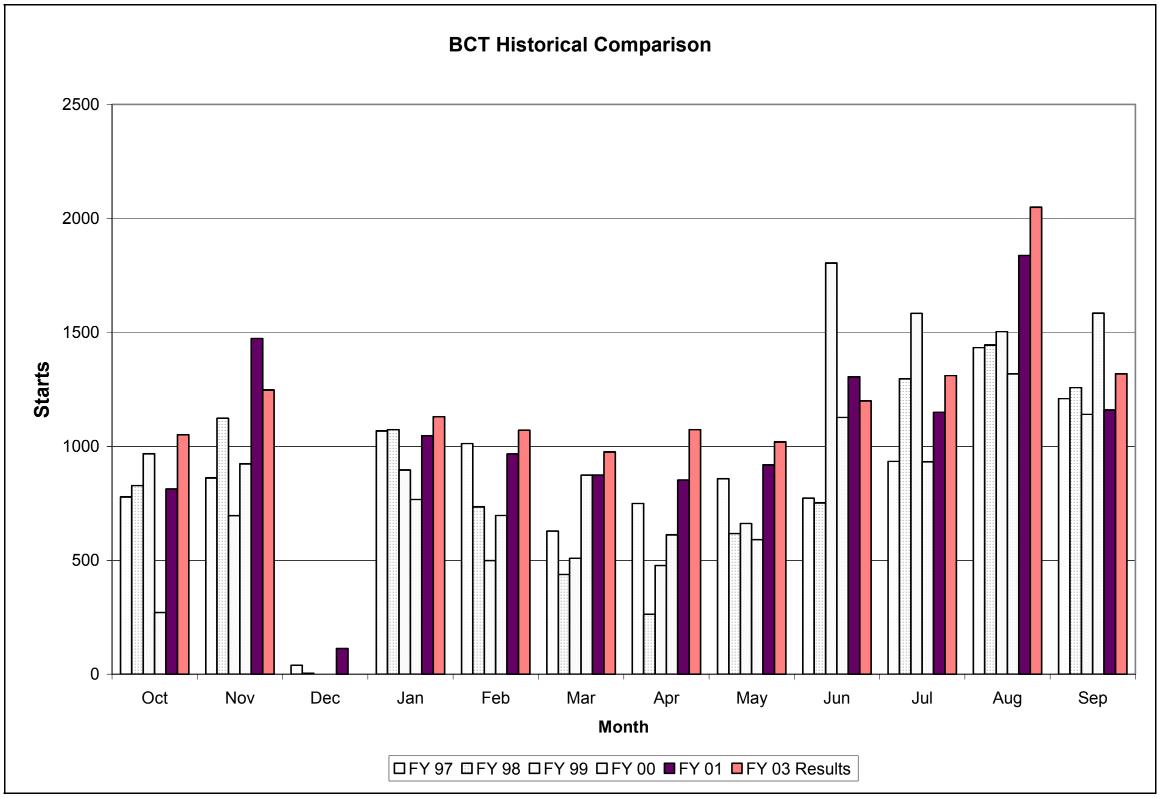

Figure 5. BCT Monthly Starts

SP1 starts for the summer months affect BCT starts for the same period. Since USAREC's focus is primarily on the NPS market, we expect total initial starts to increase. BCT starts for FY 03 are within 250 starts of FY01 for each month. We may potentially waste 200 seats each for April and August.

Basic Combat Training starts for FY 03 are slightly higher than the range for each month for past years, with the exception of November, June, July and September. Future goals require higher BCT inputs than those of the past. After FY 00, USAREC's mission changed to focus primarily on the non-prior service (NPS) market. Model results are within 250 starts of FY 01 starts each month. Starts from October through July have follow-on AIT available to support BCT. Based on historical starts, we can reasonably

expect to achieve start goals each month except for August and April, which are over 200 starts above any previous year. Assuming we will achieve at least 90% of the highest historical starts for each month, our maximum training opportunity loss for BCT is 1588.

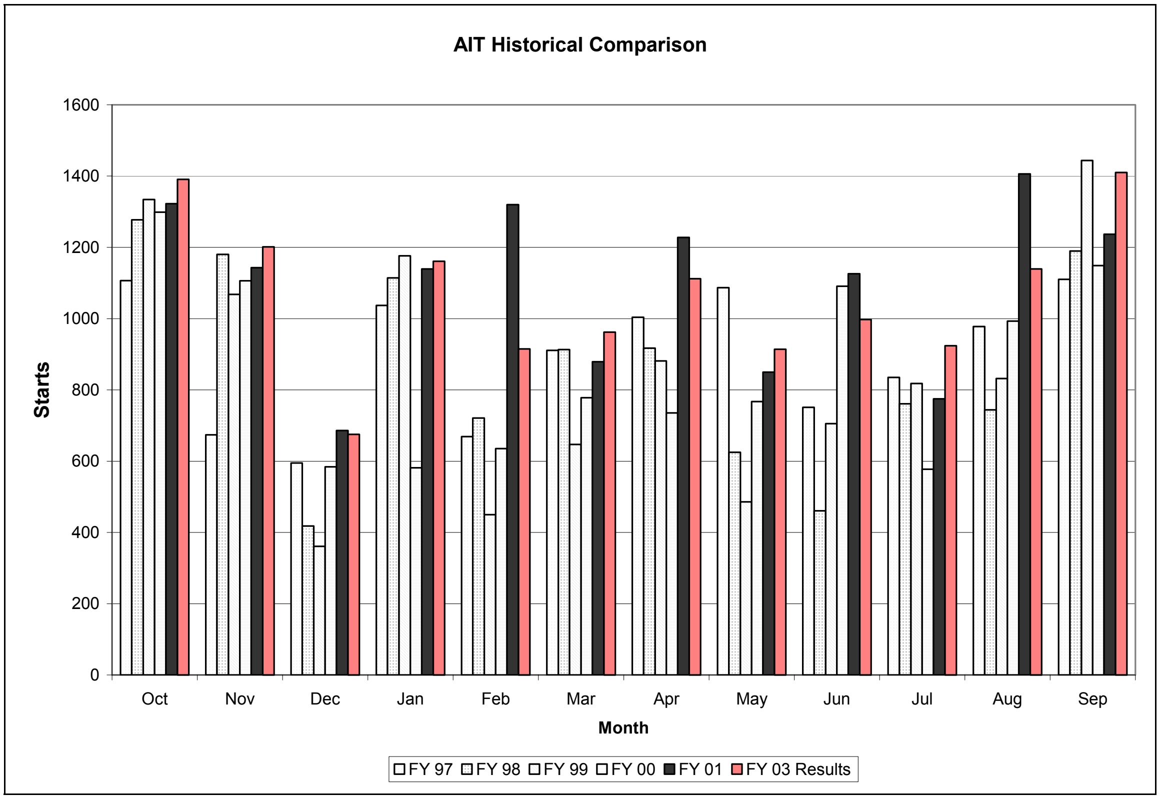

Figure 6. AIT Monthly Starts
Historical starts for the past 5 years are compared with FY 03 results from the model. The number of start weeks for each month may vary between 4 and 5 weeks from year to year except for February. FY 03 and FY 01 are within 200 starts for every month except February and August. FY 01 starts for these months are uncharacteristically high but may signify future demand since USAREC is exclusively focused on the NPS market. The model may require an adjustment to accommodate this new trend.

Advanced Individual Training starts for FY 03 are within the range of results for most months, with the exception of October, November, March, and July. Results for these months are only slightly above the range for past years. The model links starts from December through September to ensure adequate BCT is available to start AIT by MOS. FY 01 starts for February and August are uncharacteristically high but may signify future demand since USAREC is exclusively focused on the NPS market. The model may require an adjustment to accommodate this new trend. Based on historical

starts, we can reasonably expect to achieve start goals each month with some concern for October and September, our highest start months. Assuming we will achieve at least 90% of the highest historical starts for each month, our maximum training opportunity loss for AIT is 920.

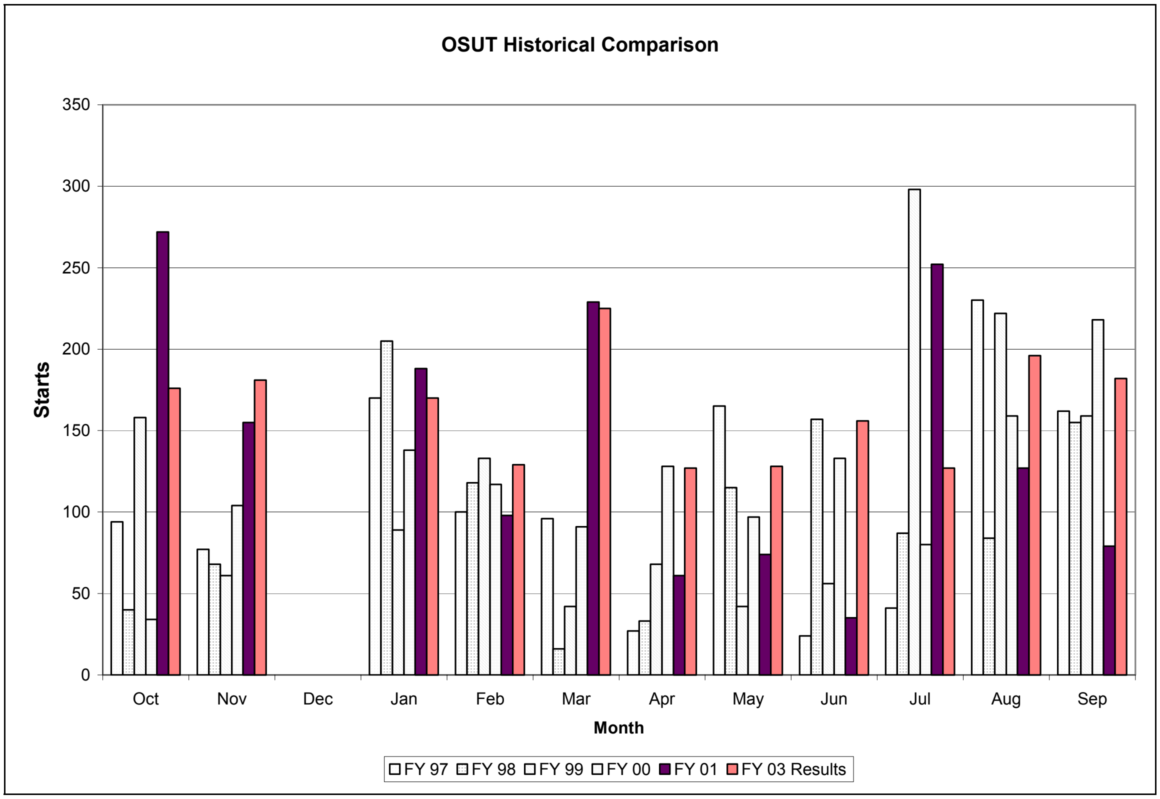

Figure 7. OSUT Monthly Starts
OSUT is designated for select MOS. Since OSUT1 and OSUT2 is actually contiguous, we use OSUT1 results to evaluate OSUT. FY 03 distribution throughout the year is smoother than previous years, fluctuating within 100 starts.

One Station Unit Training starts for each month are within the range of the months for past years except for November. Starts for these months are only slightly above the range of the past five years. However, the FY 03 distribution of starts throughout the year is smoother than previous years, fluctuating within 100 starts from month to month. Since only selected MOS participate in OSUT, starts will remain low and easy to monitor or fill. Assuming we will achieve at least 90% of the highest historical starts for each month, our maximum training opportunity loss for OSUT is 96.

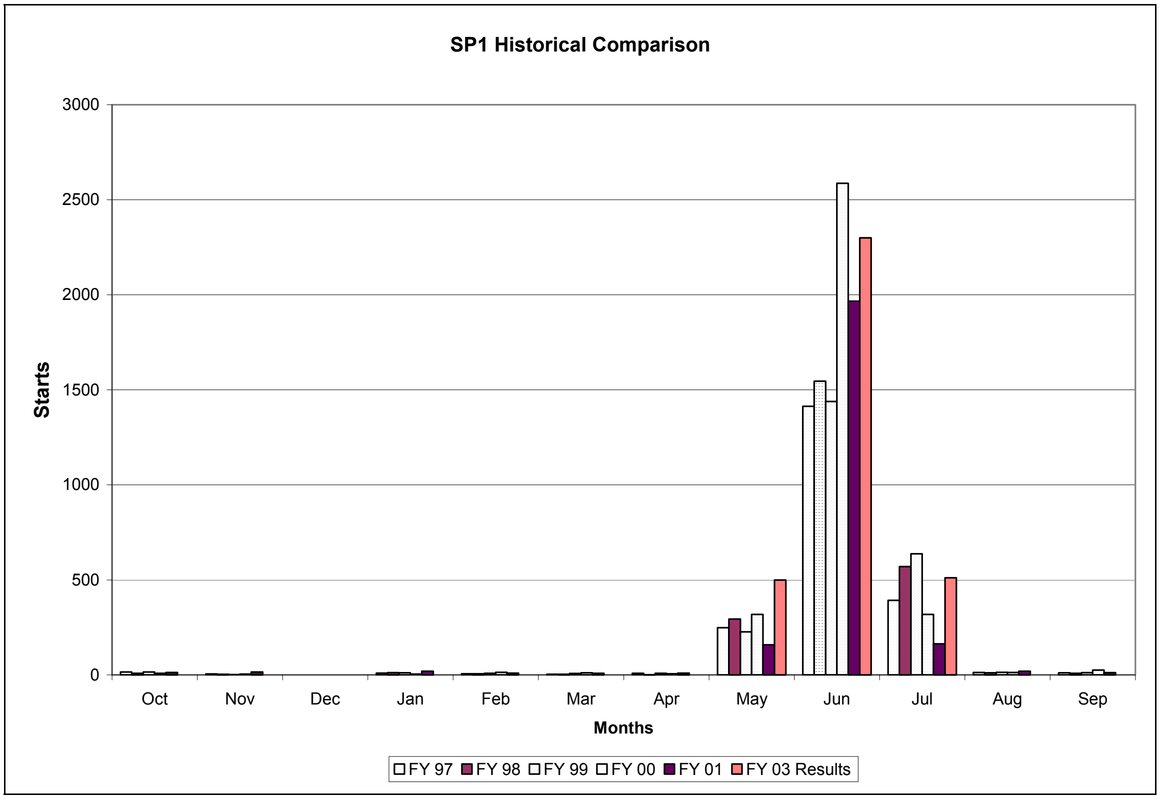

Figure 8. SP1 Monthly Starts

ODCSPER and OCAR policy for SP1 requires that most of these seats be used during the summer. Historically, Recruiting Command has filled all SP1 seats during the summer and struggled to fill any during other times of the year. Current policy is to schedule SP1 during the summer months only.

Split Option One starts for each month are within the range of the months for past years except for May. Starts for May are above the range of the past five years due to the change in policy to only conduct SP1 training during the summer. ODCSPER sets available seats in ATRRS that constrain these starts. These seats are allocated against the total BCT program. We can reasonably expect to achieve these start goals for FY 03. Assuming we will achieve at least 90% of the highest historical starts for each month, our maximum training opportunity loss for SP1 is 213.

Split Option One OSUT starts for each month are within the range of the months for past years except for May and July. ODCSPER sets available seats in ATRRS which constrain these starts. These seats are allocated against the total OSUT program. We can reasonably expect to achieve these start goals for FY 03. Assuming we will achieve at

least 90% of the highest historical starts for each month, our maximum training opportunity loss for SP1o is 38.

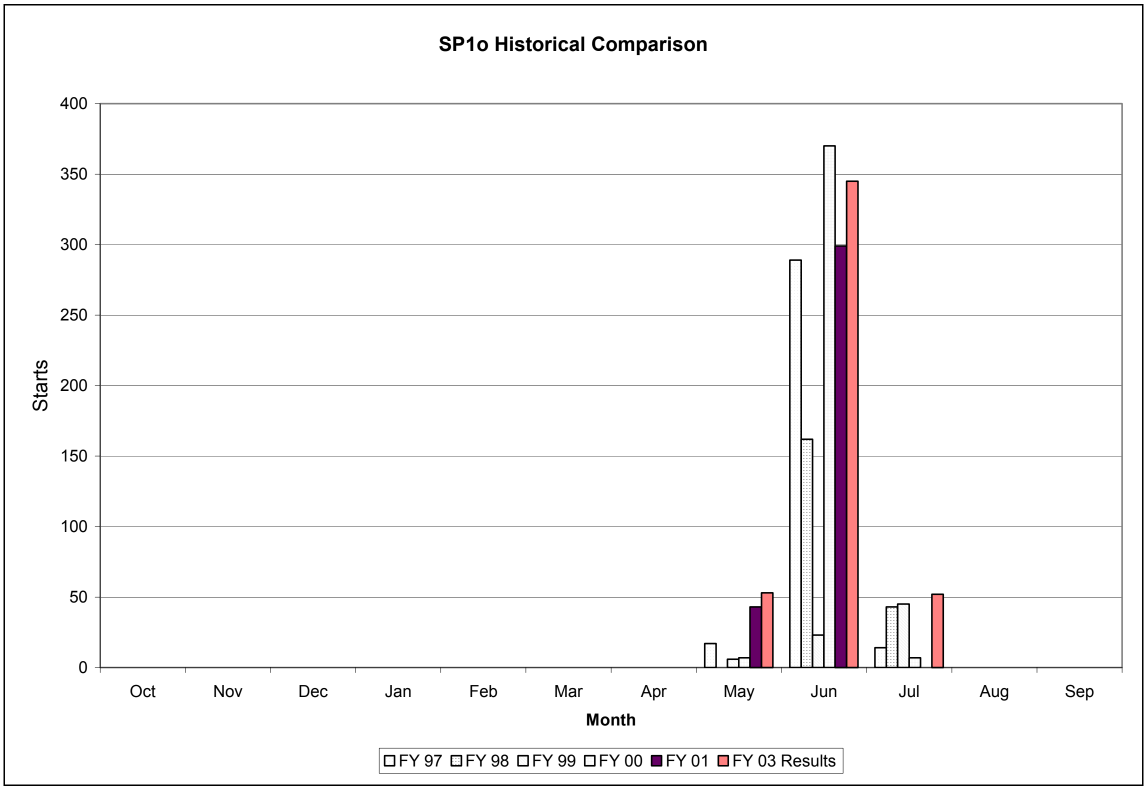

Figure 9. SP1o Monthly Starts
Current policy is to schedule SP1o during the summer months only. Policy dictates availability from year to year. The number of start weeks for each month may vary between 4 and 5 weeks from year to year. These factors cause some variance in starts for the month.

Split Option Two starts for each month are higher than the range of the months for past years except June through September. ODCSPER sets available seats in ATRRS which constrain these starts. These seats are allocated against the total AIT program. The Split Option Two training seem excessive in a select few MOS. This indicates that either regular training for these MOS are constrained and requires schedule adjustment or the goals for the MOS are much greater than historical starts and may require special attention. We should consider MOS which include 31C1, 31P1, 31R1, 31U1, 38A1, 54B1, 75B1, 75H1, 77F1, 77W1, 88H1, and 95B1. Starts for October, November, January, and March through May are of great concern and may waste as many as 850

seats or more. Assuming we will achieve at least 90% of the highest historical starts for each month, our maximum training opportunity loss for SP2 is 1053.

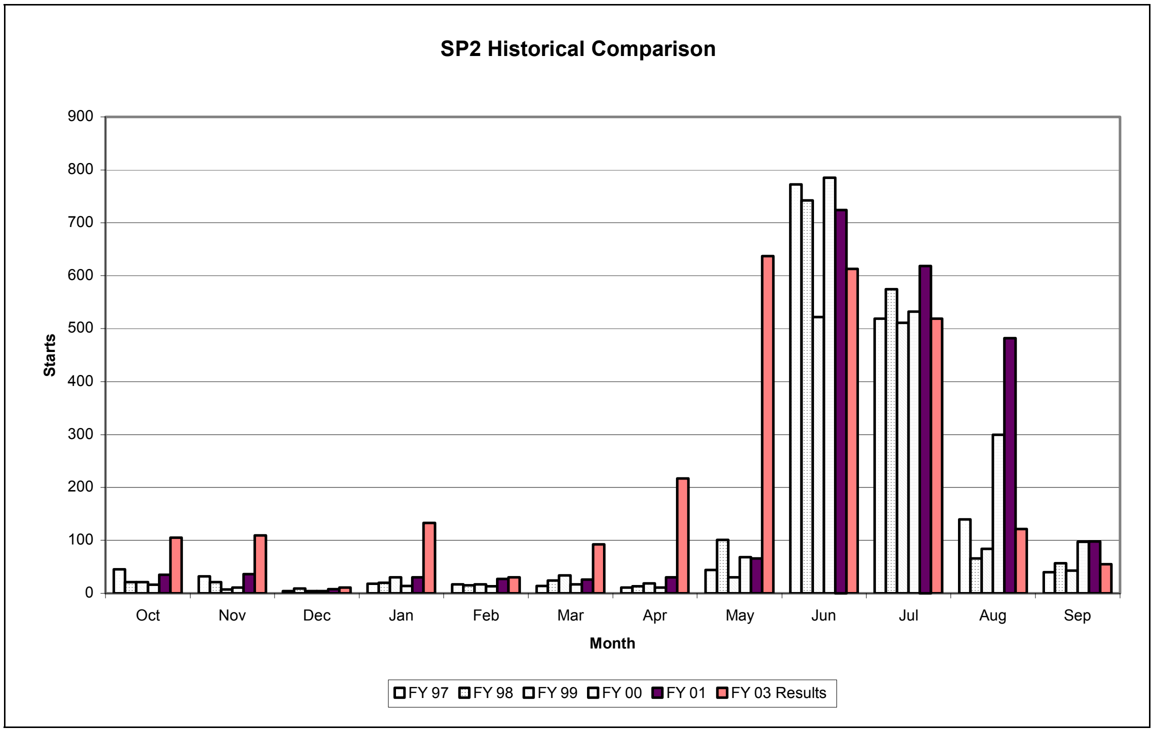

Figure 10. SP2 Monthly Starts

Policy considerations to limit MOS participating in split training may reduce the FY 03 starts. ODCSPER and OCAR aims to have most SP2 training occur during the summer months. The majority of MOS starts for May include 75B1, 75H1, 31C1, 31U1, and 54B1. Split Two starts for October, November, January, and March through May are of concern. The model may require adjustment to limit starts for these months.

Split Option Two OSUT starts for each month are within the range of the months for past years except April, May, and July through September. ODCSPER sets available seats in ATRRS which constrain these starts. These seats are allocated against the total OSUT program. The large spike in August is primarily MOS 54B1 and 95B1. Starts for April, August and September are of concern and may result in 200 wasted seats. June should be able to achieve more seats based on historical starts. Assuming we will achieve at least 90% of the highest historical starts for each month, our maximum training opportunity loss for SP2o is 310.

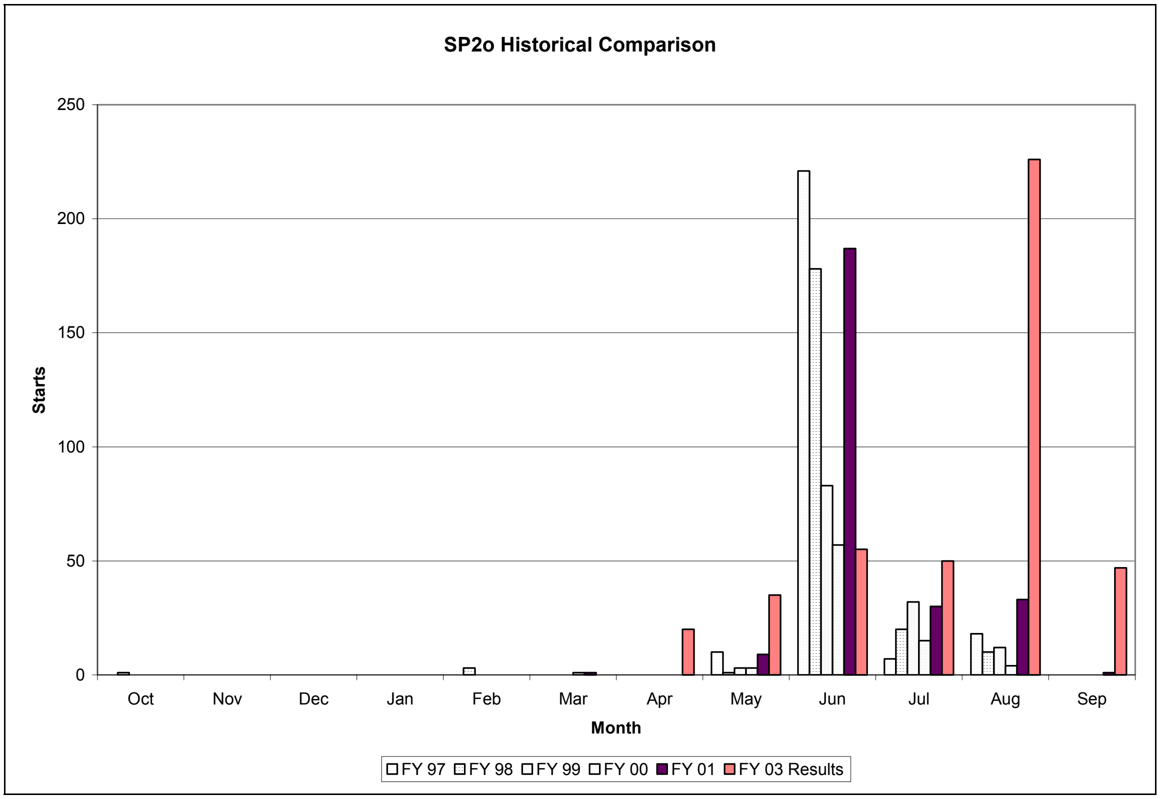

Figure 11. SP2o Monthly Starts

August SP2o primarily consists of 54B1 and 95B1. This is the only month these MOS have SP2o training available. Moving available seats to other periods may increase projected starts for these MOS, thus reaching SMDR objectives.

The current model achieves the 19,000 funded seats goal (initial starts). Advanced starts sum to over 17,500. Assuming at least 90% achievement in starts for FY 03 versus the highest historical starts for each month, the maximum probable loss of seats is 2379 for advance starts and 1935 for initial starts. This implies that at least 15,000 soldiers will become DMOSQ in FY 03.

2. MOS Goals (SDMR)

Most starts by MOS were close to the SMDR targets with a few exceptions. Since the total MOS goal from the SMDR summed to approximately 17,000, many MOS starts exceeded the SMDR goals. The MOS with no seats are either slated for deletion or require training beyond AIT phase one; some MOS have more than one AIT phase. The table below shows which MOS had no seats available, which had starts below the SMDR goals and which had over 50 starts more than the prescribed goals. Most MOS with starts above the goal had a much higher input to training in FY 01 and earlier.

Status	MOS
Goals w/o seats	52E1 (Maint); 81L1, 81T1, 82D1, 82T1 (Topographers)
	91C1, 91V2 (Medical); 98C1 (Intelligence)
under goal	12C1 (Field Artillery); 38A1 (Civil Affairs)
	54B1 (Chemical); 88H1 (Transportation)
	95B1 (Military Police)
50+ above goal	19K1 (Armor); 31C1, 31L1, 31R1, 31U1 (Signal)
	71L1 (Admin); 73C1 (Finance); 75B1 (Personnel)
	91D1 (Medical); 92Y1 (Supply); 96B1 (Intelligence)

Table 3. MOS Deviation
Seats are available for under goal MOS, but the current placement of available seats constrains their use. High historical starts enable some MOS to achieve excess starts to SMDR goals for FY 03.

Those MOS with excessive starts compared to historical utilization are 19K1, 31C1, 31U1, and 75B1. If necessary, we may limit total starts for these MOS to some target or add an additional penalty for exceeding a particular limit.

3. Other Start Goals

The current model achieves the 19,000 funded seats goal (initial starts) as a result of the asymmetric penalties for the elastic goal variables. We derived input to training goals for each month by normalizing the average historical starts per month and multiplying the fractional value of each month by 19000. We then rounded down to the nearest hundred so that the sum of the monthly goals would not exceed *fymaxgoal*. We discuss the effect of penalties on the results below.

D. SENSITIVITY ANALYSIS

In the model, we apply special penalties to violations to the goal program. The relative weight of penalties has an effect on the resulting output of the model. We will examine the affect of changing weights at the macro level; total initial training starts (BCT, OSUT1, SP1 and SP1o).

1. *Pengoal$_n$* With Stable Scale

The charts below depict the effect on total initial training starts when *pengoal$_n$* is stable while *penunder* and *penfymaxgoal* change. When *pengoal$_n$* is not weighted, the number of initial training starts is sensitive to the relative weight of *penunder* to *penfymaxgoal*. If *penunder* is larger than *penfymaxgoal*, initial training starts may exceed 19000, the number of funded seats for the fiscal year. When *penunder* is one, advance training starts (AIT, OSUT2, SP2, and SP2o) are below MOS goals for the fiscal year.

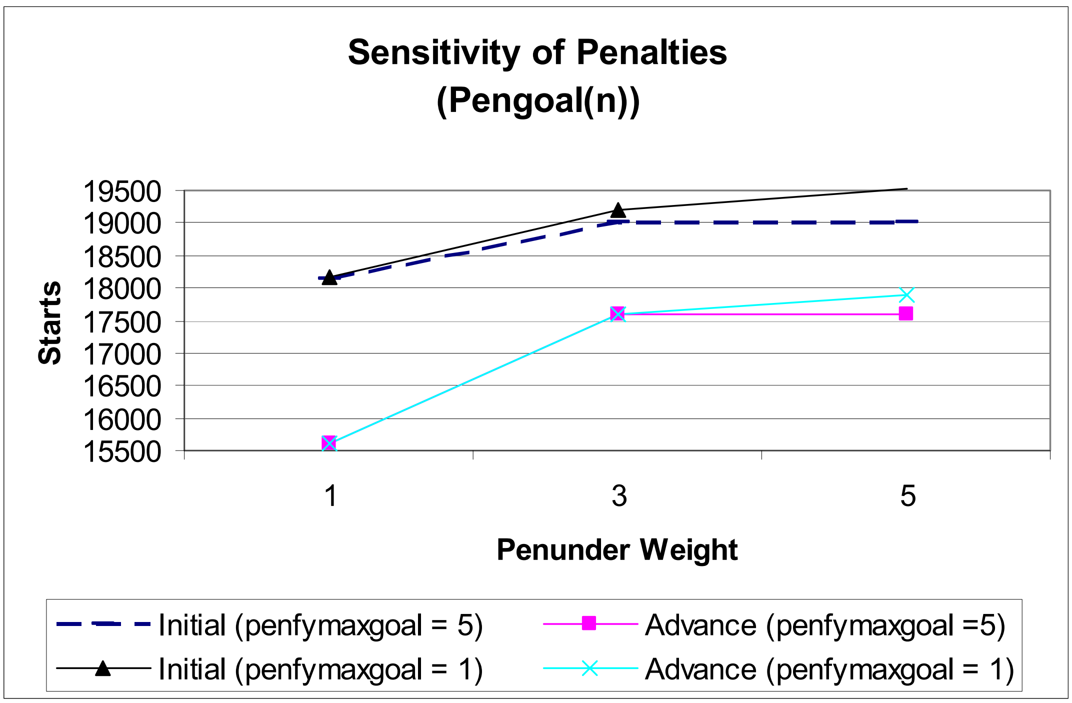

Figure 12. *Pengoal$_n$* Stabilized
The change in *penfymaxgoal* affects initial starts. When *penfymaxgoal* is greater than *penunder*, it has an asymptotic affect on initial starts. A change in *penunder* has a positive correlation with the change in starts. The sensitivity of starts to *penunder* is not linear.

When *pengoal$_n$* is multiplied by a priority scale of three, the number of initial training starts is sensitive to the weight of *penunder* relative to *penfymaxgoal*. If *penunder* is larger than *penfymaxgoal*, initial training starts may exceed 19000; the number of funded seats for the fiscal year. When *penfymaxgoal* is greater than or equal to *penunder*, initial training starts are held within the 19,000 funding level. Figures 12

and 13 depict the effect on total initial and advance starts when *pengoaln* is weighted differently. Note that advance starts are higher when *pengoal*$_n$ is higher than *penunder*. This demonstrates the gravitational effect of weights on the goal as shown in Figure 4 (Penalties to Achieve Goals) above.

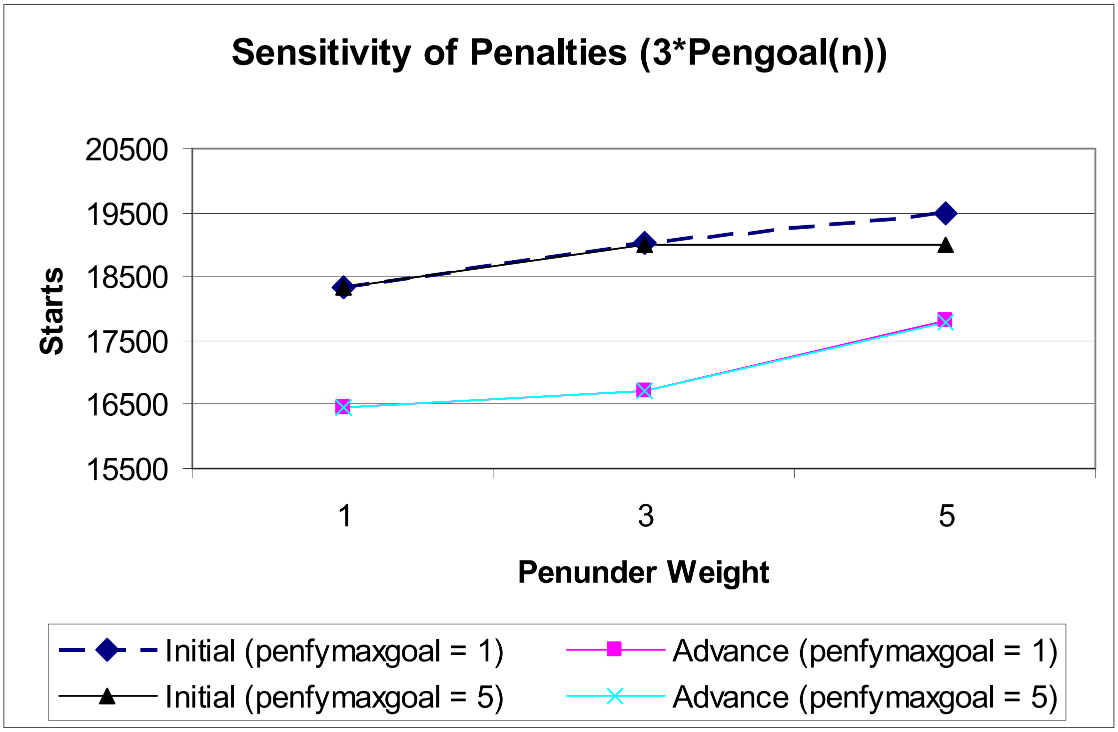

Figure 13. *Pengoal*$_n$ * 3 Stabilized
The change in *penfymaxgoal* affects initial starts. When *penfymaxgoal* is greater than *penunder*, it has an asymptotic affect on initial starts. A change in *penunder* has a positive correlation with the change in starts. However, the rate of change is small when the MOS penalty is larger. The sensitivity of starts to *penunder* is not linear

2. *Pengoal*$_n$ With Varied Scales

In the remaining charts, we stabilized *penfymaxgoal* at a penalty of ten and varied the penalty weight of *penunder* and *pengoal*$_n$. Figure 14 shows the combined effect of increasing both *penunder* and *pengoal*$_n$. The sum total of the MOS goals is approximately 17,000. Therefore, the increase in *pengoal*$_n$ penalties will gravitate advance starts around 17,000. However, *penunder* pulls both initial and advance starts until all goals are met. Once all goals are met, additional starts are feasible unless the

penalty for exceeding the highest goal, *fymaxgoal*, is large. If the *penunder* is equal to the penalty for exceeding the goal, advance starts are very sensitive to $pengoal_n$. If *penunder* is much larger than the penalty for exceeding the goal and $pengoal_n$, then the latter has little effect.

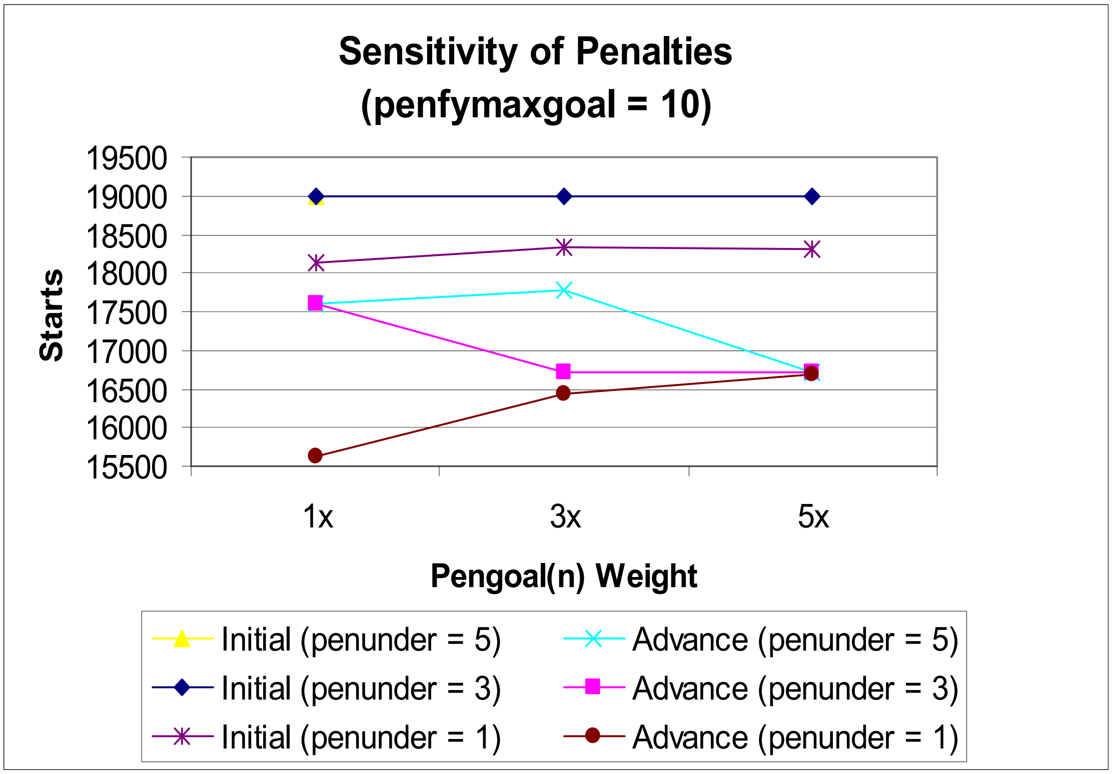

Figure 14. $Pengoal_n$ With Varied Scale
Penfymaxgoal limits initial starts which affects advanced starts. The relative value of *penunder* to the MOS penalty affects the advance starts. Higher MOS penalties causes the advance starts to gravitate to the MOS goal.

When *penunder* is larger than the penalty for exceeding the goal but relatively close to the weight of $pengoal_n$, advance starts become sensitive to penalties by MOS, while gravitating toward initial start goals for input to training by month and the fiscal year. The table 4 below provides MOS level details for $pengoal_n$ weights in Figure 15.

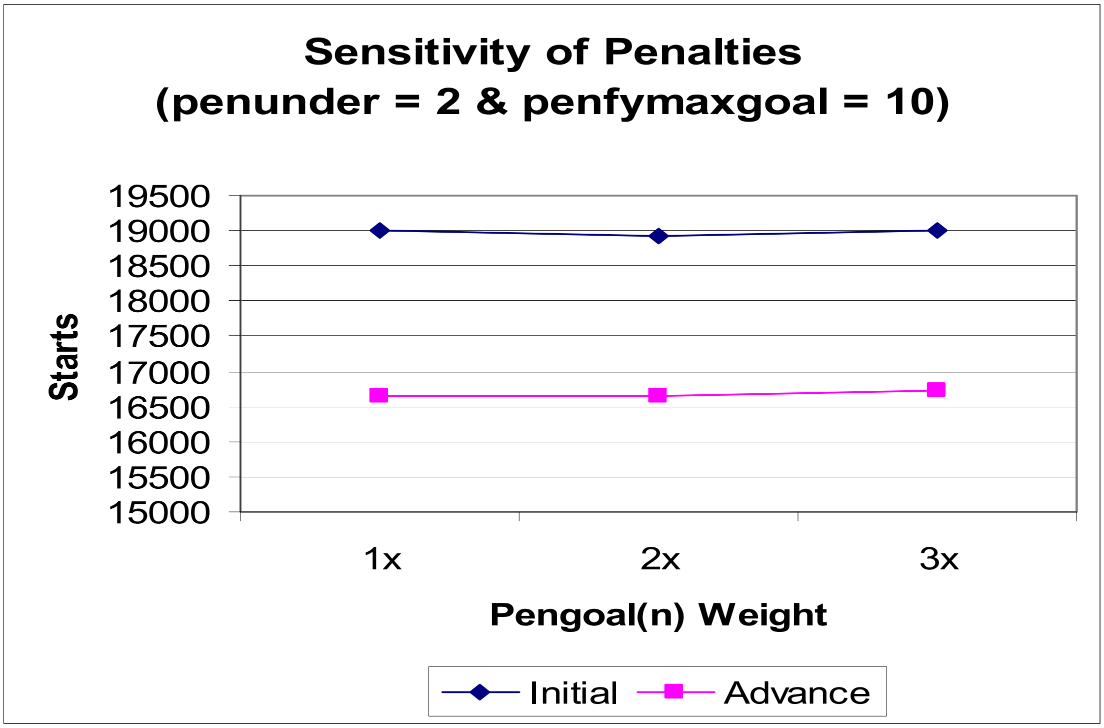

Figure 15. Sensitive $Pengoal_n$ versus *Penunder*
The MOS penalty is sensitive to the slightest change when *penunder* is equal to 2 or less, but has a small affect on total starts.

Weight	Status	MOS
1x	below goal	12C1 (Engineer); 38A1 (Civil Affairs)
		54B1 (Chemical); 88N1 (Transportation)
		95B1 (Military Police)
	50+ above goal	31U1 (Signal)
2x	below goal	12C1, 38A1, 95B1
3x	below goal	38A1

Table 4. *Pengoaln* Weight Effect on Advance Starts
When *penunder* = 2, as the weight of $pengoal_n$ increases it achieves more MOS goals and reduces overages for other MOS.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This model provides an IET schedule for FY 03 for the Army Reserve that optimally allocates funded training resources to improve TPU readiness. The model uses goal programming to achieve fiscal year MOS goals established by the SMDR. It eliminates mismatches between BCT and AIT, which was a cause of lost training resources in the past. This model takes into account historical utilization of IET seats as a parameter in establishing FY 03 starts. This approach enables the Army Reserve to set various goals for the planning year and establish a schedule that remains responsive to historical starts.

This model will easily accommodate policy changes and additional constraints. As the Army Reserve negotiates during the TRAP, it can input constraints stipulated through negotiations and determine the effect of these additional limitations and resulting schedule changes. If MOS readiness prioritization within the Army Reserve occurs, we will simply establish weights for these priorities as part of the input data.

When an adequate number of seats are available for a particular MOS but are not used in model results, e.g. 12C1, 38A1, 54B1, and 95B1, this indicates a need to adjust the current schedule for these particular MOS. Users should reschedule seats from the weeks where MOS with excess starts occur and into weeks where future starts for a particular type of training do not exceed the historical starts for that month. If we select a *penunder* that is small, we will not detect the misplacement of training seats.

This model requires data inputs from ATRRS and TAPDB-R. The Army Reserve must download files from these databases and manipulate the information in spreadsheets for proper formatting as “include” files in the GAMS model.

The Army Reserve currently experiences about a 20% loss in IET seats and often lacks seats in shortage MOS. The Army Reserve is increasing the funding level for seats from 18,000 to 19,000 in FY 03 and FY 04. As the Army Reserve determines the true demand for IET seats through recruitment, retention and readiness, this model will take the resulting goals and recommend a training seat allocation consistent with those goals.

This model incorporates past demand as well as MOS shortages to provide results that are within the achievable range of past years by month and type training seat.

We identified starts that may become possible losses by seat type and month. Assuming that we will achieve at least 90% of the highest historical start for each month and type, the maximum for initial seat losses is 1935 (BCT = 1588, OSUT = 96, SP1 = 213, SP1o = 38). The maximum for advance seat losses is 2379 (AIT = 920, OSUT = 96, SP2 = 1053, SP2o = 310). Therefore, the maximum probable seat loss for this model is less than or equal to 2379 or approximately 13% of 19,000. We can reasonably expect to fill all starts except for those identified in the table below.

TYPE

MONTH	BCT	SP2	SP2o
October		50	
November		50	
January		100	
March		50	
April	200	150	20
May		450	
August	200		150
September			30
Total	400	850	200

Table 5. Expected Seat Waste
Predicted seat losses indicate a need to rearrange the current IET schedule for Split Option Two variants as discussed in chapter 3.

We expect a reduction in IET seat loss from 20% to approximately 15%. This increase in utilization is due to placement of seats in accordance with historical use, MOS seat availability, and the linkage of BCT to AIT. This means that over 15,000 Reserve soldiers will become DMOSQ during FY 03, improving readiness in TPUs. In previous years, fewer than 13,000 Reserve soldiers became DMOSQ in a given year.

B. RECOMMENDATIONS

The OCAR, Personnel Division should implement this model to help in the TRAP process. Personnel Division already has the computer, the GAMS program, and the CPLEX solvers needed to implement this model. Personnel Division should request reports from ATRRS and TAPDB-R that will easily accommodate the format of input data to the model. Alternately, Personnel Division may import raw data to EXCEL or some other data manipulation software to create input data files for the model. This would be a powerful tool to adjust shortcomings found in ATRRS and validate any additional applications that resource and schedule IET seats.

C. FURTHER RESEARCH

1. Readiness Prioritization of MOS in Troop Program Units

The Army Reserve needs to determine ten to 20 top priority military specialties for recruitment, training and retention. Currently, the Army Reserve designates TPUs with a priority category consistent with the unit mission. The Army Reserve is primarily made up of Combat Support and Combat Service Support units. The Army Reserve categorizes these units into Force Support Packages that have every type of unit and most military specialties. As a result, a particular military specialty is not easily determined by unit type nor can a particular shortage of a military specialty automatically seem more important than any other military specialty. Several organizations within the Army Reserve, i.e., OCAR and the U. S. Army Reserve Command, are addressing the issue of military specialty prioritization without resolution. If the Army Reserve were to give priority designations to military specialties, it could use this priority to apply a penalty for particular IET seat shortages.

2. Appropriating Incentives and Bonuses to Improve Readiness and Training Seat Utilization

The Army Reserve needs to determine a method of appropriating incentives that will improve readiness and improve training seat utilization. Currently, the Army Reserve gives incentives for assignment to high–priority units and designated military specialties to attract personnel in the local area and thereby improve personnel readiness. Consequently, selected units acquire personnel and require IET seats for particular specialties. The Army Reserve does not link incentives to the number of available

training seats, military specialty fill rates, military specialty qualification rates, or military specialty attrition rates. Incentives are not sensitive to IET seat utilization opportunities. As a result, many training opportunities are lost, high demand for IET seats of high priority unit military specialties persists, and the ability to persuade individuals to switch to a military specialty with no incentive and a readily available IET seat is inhibited.

APPENDIX A: GAMS OUTPUT

A. WHEN *PENUNDER* WEIGHT IS FIVE

1. MOS Output by Type

The *penfymaxgoal* is weighted as 10 and $pengoal_n$ is weighted without a readiness priority multiple.

MOS	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Initial	Advance
02K1	0	0							0	0
11B1	7	7	32	26		21		21	60	54
11C1			3	2		2		2	5	4
11H1			4	4		2		2	6	6
11M1						5		5	5	5
12B1	2	2	465	443	29	156	29	156	652	630
12C1			104	99	6	24	6	7	134	112
13B1			6	4					6	4
13F1	3	3							3	3
13M1	2	2							2	2
14S1	2	2							2	2
19D1						5		5	5	5
19K1			3			9		9	12	9
27D1	76	80							80	76
27E1	1	1							1	1
31C1	28	29			67		67		97	95
31F1	27	28							28	27
31L1	85	89			84		84		173	169
31P1	10	11							11	10
31R1					138		138		138	138
31U1	153	161			874		205		1035	358
33W1	4	4							4	4
35E1	35	37							37	35
35F1	7	7							7	7
35H1	1	1							1	1
35J1	8	8							8	8
35L1	2	2							2	2
35M1	7	7							7	7
35N1	26	27							27	26
35R1	6	6							6	6
37F1	339	356							356	339
38A1	123	129			237		237		366	360
39B1	1	1							1	1
44B1	7	8			29		29		36	36
44E1	15	16			13		13		29	28
45B1	20	21			19		19		40	39

MOS	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Initial	Advance
45D1	3	3							3	3
45G1	4	4							4	4
45K1	6	6							6	6
51R1	42	45							45	42
51T1	12	13			28		28		41	40
52C1	69	72							72	69
52D1	145	152							152	145
54B1	6	6	651	620	76	103	76	103	836	804
55B1	235	247							247	235
55D1	1	1							1	1
56M1	40	42							42	40
62B1	209	219							219	209
62E1	155	163							163	155
62F1	128	134							134	128
62G1	75	79							79	75
62H1	48	50							50	48
62J1	246	258							258	246
63A1	22	23							23	22
63B1	302	317							317	302
63D1	2	2							2	2
63G1	36	38							38	36
63H1	12	13							13	12
63J1	124	130							130	124
63M1	5	5							5	5
63S1	511	537							537	511
63W1	279	293							293	279
63Y1	14	15							15	14
67R1	11	12							12	11
67S1	1	1							1	1
67T1	18	19							19	18
67U1	51	54							54	51
68B1	9	9							9	9
68D1	12	13							13	12
68F1	5	5							5	5
68G1	11	12							12	11
68N1	5	5							5	5
68X1	8	8							8	8
68Y1	3	3							3	3
71G1	5	5							5	5
71L1	540	567							567	540
73C1	128	134							134	128
73D1	17	18							18	17
74B1	96	101							101	96
74C1	56	59							59	56
75B1	130	137			134		134		271	265

MOS	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Initial	Advance
75F1	35	37			24		24		61	59
75H1	193	203			176		176		379	370
77F1	291	306			937		937		1243	1228
77L1	23	24			22		22		46	45
77W1	96	101			235		235		336	331
88H1	124	130			164		164		294	288
88K1	22	23			19		19		42	41
88L1	30	32							32	30
88M1	1649	1731							1731	1649
88N1	358	376							376	358
88P1	10	11							11	10
88T1	11	12							12	11
88U1	11	12							12	11
91A1	32	34							34	32
91D1	132	139							139	132
91E1	134	141							141	134
91G1	64	67							67	64
91H1	20	21							21	20
91J1	132	139							139	132
91K1	135	142							142	135
91M1	186	195							195	186
91P1	96	101							101	96
91Q1	32	34							34	32
91R1	35	37							37	35
91S1	52	55							55	52
91T1	15	16							16	15
91V1	5	5							5	5
91W1	1236	1298							1298	1236
91X1	101	106							106	101
92A1	854	897							897	854
92G1	459	482							482	459
92M1	63	66							66	63
92R1	90	94							94	90
92S1	297	312							312	297
92Y1	386	405							405	386
93C1	1	1							1	1
93P1	29	30							30	29
95B1	241	253	502	479		123		123	878	842
95C1	8	8	26	25					35	33
96B1	109	114							114	109
96D1	35	37							37	35
96R1	1	1							1	1
97B1	49	51							51	49
97E1	29	30							30	29
97L1	35	37							37	35

MOS	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Initial	Advance
98G1	5	5							5	5
98J1	15	16							16	15
Grand Total	12802	13443	1796	1702	3311	450	2642	433	19000	17579

Table 6. MOS Output by Type (*penunder* = 5)

2. Weekly Output by Type

This schedule does not delineate by MOS but the data is available as output from the model.

Start Week	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Grand Total
w30Sep02	24	379	68	91					563
w07Oct02	539	434	81	127			46		1226
w14Oct02	444	239	24						706
w21Oct02	384		3				59		446
w28Oct02	294	212		56			50		612
w04Nov02	287	177	130	42			25		660
w11Nov02	178	319							497
w18Nov02	292	315	51	9			15		682
w25Nov02	150	224		64			19		457
w02Dec02	324			75			8		407
w09Dec02	314			22			3		339
w16Dec02	38			3					41
w06Jan03	498	2	16				11		527
w13Jan03	199	616		121			56		992
w20Jan03	166	386	102				13		667
w27Jan03	298	126	52	47			53		576
w03Feb03	211	341	69				16		636
w10Feb03	200	331	13				14		558
w17Feb03	458	392							850
w24Feb03	46	7	47						100
w03Mar03	23	273		15			6		317
w10Mar03	2	256	58				5		321
w17Mar03	577	176	166	95			26		1041
w24Mar03	360	271		48			55		734
w31Mar03	118	180		64			78		440
w07Apr03	319	201	99	12			62		693
w14Apr03	308	252					19		578
w21Apr03	367	440	28	44			58	20	957
w28Apr03	7	238					163		407
w05May03	254	192	29	54			92	20	642
w12May03	238	372		155			133		897
w19May03	164	192	5		180	53	161	15	769
w26May03	252	26	94		320		88		780
w02Jun03	168	330	34	92	86	161	108	20	998
w09Jun03	187	261	7		673	156	157		1440
w16Jun03	234	185	29	26	868	28	128	34	1533

Start Week	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Grand Total
w23Jun03	409	423	86		673		221		1813
w30Jun03	221	331		27	431		102		1112
w07Jul03	179	288	25			52	137	20	701
w14Jul03	346	315	97	5	80		120	23	985
w21Jul03	179	376	5	87			160	7	814
w28Jul03	24	143	62	31			36		296
w04Aug03	307	439	78	6			57	226	1112
w11Aug03	242	358	1	27			8		636
w18Aug03	172	258		80			7		518
w25Aug03	394	852	55				14		1314
w01Sep03	310	344	3	23					680
w08Sep03	256	388	54	91			8	24	820
w15Sep03	260	119	125	4			6		515
w22Sep03	347	466		58			32	24	926
w29Sep03	237						9		246
Grand Total	12802	13443	1796	1702	3311	450	2642	433	36579

Table 7. Weeky Output by Type (*penunder* = 5)

3. Monthly Output by Type

These results may help establish input to training goals.

Month	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Grand Total
mOct02	1391	1051	176	218	0	0	105	0	2941
mNov02	1201	1247	181	171	0	0	109	0	2909
mDec02	675	0	0	100	0	0	11	0	786
mJan03	1161	1130	170	168	0	0	133	0	2762
mFeb03	915	1071	129	0	0	0	30	0	2145
mMar03	962	975	225	158	0	0	92	0	2412
mApr03	1112	1073	127	120	0	0	217	20	2669
mMay03	914	1019	128	209	500	53	637	35	3495
mJun03	998	1199	156	118	2300	345	613	55	5784
mJul03	924	1310	127	119	511	52	519	50	3612
mAug03	1139	2049	196	145	0	0	121	226	3876
mSep03	1410	1318	182	176	0	0	55	47	3188
Grand Total	12802	13442	1797	1702	3311	450	2642	433	36579

Table 8. Monthly Output by Type (*penunder* = 5)

4. Output by MOS by Week by Type

This is a sample of the output results for the model.

MOS	WEEK	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Grand Total
11B1	02Jun03	3								3
	03Feb03		1							1
	03Mar03	1	1		8					10
	05May03	1								1
	06Jan03			8						8
	07Apr03	1								1
	07Jul03						3			3
	08Sep03				12					12
	09Jun03						18			18
	11Aug03				7					7
	14Jul03			13					2	33
	15Sep03			4						4
	16Jun03			7						7
	21Jul03									1
	25Aug03		1							1
	28Apr03		1							1
	30Jun03	1								1
	31Mar03		3							3
11B1 Total		7	7	32	26		21		2	114
11C1	02Jun03			1						1
	07Jul03						1			1
	08Sep03			1	1					2
	09Jun03						1			1
	14Jul03			1						3
	28Jul03				1					1
11C1 Total				3	2		2			9
11H1	02Jun03			2						2
	07Jul03						2			2
	08Sep03				2					2
	14Jul03			2						2
	21Jul03									2
	28Jul03				2					2
11H1 Total				4	4		2			12
11M1	07Jul03						5			5
	21Jul03									5
11M1 Total							5			10
12B1	01Sep03				19					19
	02Dec02				67					67
	02Jun03			18	51		49		2	138

MOS	WEEK	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Grand Total
	03Feb03							4		4
	04Nov02							4		4
	05May03			24	47				2	91
	06Jan03	2						2		4
	07Apr03			55	11					66
	07Jul03			20			39		2	79
	07Oct02			72						72
	08Sep03			43	67				2	130
	10Feb03			12						12
	10Mar03			50				4		54
	11Aug03				16					16
	14Apr03							3		3
	14Jul03			72						72
	15Sep03		2							2
	16Jun03			18		29	19		2	86
	17Mar03				18					18
	18Nov02			9						9
	19May03						49		1	64
	20Jan03			19				4		23
	21Apr03								2	20
	22Sep03				49				2	69
	24Mar03							4		4
	25Nov02							4		4
	27Jan03				8					8
	28Jul03			53	16					69
	28Oct02				50					50
	30Jun03				22					22
12B1 Total		2	2	465	443	29	156	29	15	1282
12C1	01Sep03				5					5
	02Dec02				8					8
	02Jun03			5	6		9			19
	03Feb03							1		1
	03Mar03				7					7
	04Nov02			8				1		9
	05May03			5	7					12
	06Jan03			8				1		9
	07Apr03			6	1					7
	07Jul03			5			2			7
	07Oct02			9						9
	08Sep03			9	8					21
	10Feb03			1						1
	10Mar03			8				1		9
	11Aug03			1	4					5
	13Jan03				7					7
	14Jul03			9	5					14

MOS	**WEEK**	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Grand Total
	16Dec02				3					3
	16Jun03			5			9			14
	18Nov02				6					6
	19May03			5			3			9
	20Jan03							1		1
	21Apr03				8					8
	21Oct02			3						3
	22Sep03				8					12
	23Jun03					6				6
	24Feb03			9						9
	24Mar03							1		1
	25Nov02							1		1
	28Jul03			9	4					13
	28Oct02				6					6
	30Jun03				4					4
	30Sep02				0					0
12C1 Total				104	99	6	24	6		246
13B1	08Sep03			1						1
	15Sep03				4					4
	21Jul03			5						5
13B1 Total				6	4					10
13F1	06Jan03		1							1
	10Mar03	1								1
	18Nov02	1								1
	22Sep03		2							2
	24Feb03	1								1
13F1 Total		3	3							6
13M1	04Aug03		2							2
	21Oct02	1								1
	28Oct02	1								1
13M1 Total		2	2							4
14S1	02Jun03		1							1
	04Aug03	1								1
	07Oct02	0								0
	11Nov02		1							1
	27Jan03	1								1
14S1 Total		2	2							4
19D1	09Jun03						5			5
	16Jun03									5
19D1 Total							5			10
19K1	01Sep03			3						3

MOS	WEEK	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Grand Total
	09Jun03						9			9
	16Jun03									9
19K1 Total				3			9			21

Table 9. Output by MOS by Week by Type

B. WHEN *PENUNDER* WEIGHT IS TWO

1. MOS Output by Type

The *penfymaxgoal* is weighted as 10 and *pengoal*$_n$ is weighted without a readiness priority multiple.

MOS	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Initial	Advance
02K1	0	0							0	0
11B1	7	7	51	44		21		3	79	54
11C1			2	1		9		3	11	4
11H1			4	4		19		19	23	23
11M1						5		5	5	5
11X1					10				10	0
12B1	2	2	486	463	48	136	29	136	673	630
12C1			104	99	6	24	6	1	134	106
13B1			6	4					6	4
13F1	2	2							2	2
13M1	2	2							2	2
14S1	2	2							2	2
19D1			1	1		4		4	5	5
19K1			23	19					23	19
27D1	76	80							80	76
27E1	1	1							1	1
31C1	21	22			24		24		46	45
31F1	27	28							28	27
31L1	47	49			32		32		81	79
31P1	10	11							11	10
31R1	22	23			46		46		69	68
31U1	164	172			1280		57		1452	221
33W1	4	4							4	4
35E1	35	37							37	35
35F1	7	7							7	7
35H1	1	1							1	1
35J1	8	8							8	8
35L1	2	2							2	2
35M1	4	4							4	4
35N1	23	24							24	23
35R1	5	5							5	5

MOS	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Initial	Advance
37F1	339	356							356	339
38A1	130	137			230		230		367	360
39B1	1	1							1	1
44B1	19	20			221		17		241	36
44E1	14	15			7		7		22	21
45B1	21	22			7		7		29	28
45D1	3	3							3	3
45G1	4	4							4	4
45K1	6	6							6	6
51R1	29	30							30	29
51T1	24	25			16		16		41	40
52C1	44	46							46	44
52D1	139	146							146	139
54B1	16	17	588	560	66	103	66	103	773	744
55B1	235	247							247	235
55D1	1	1							1	1
56M1	40	42							42	40
62B1	209	219							219	209
62E1	155	163							163	155
62F1	128	134							134	128
62G1	75	79							79	75
62H1	48	50							50	48
62J1	246	258							258	246
63A1	22	23							23	22
63B1	283	297							297	283
63D1	2	2							2	2
63G1	36	38							38	36
63H1	12	13							13	12
63J1	120	126							126	120
63M1	5	5							5	5
63S1	511	537							537	511
63W1	279	293							293	279
63Y1	14	15							15	14
67R1	11	12							12	11
67S1	1	1							1	1
67T1	18	19							19	18
67U1	51	54							54	51
68B1	9	9							9	9
68D1	12	13							13	12
68F1	5	5							5	5
68G1	11	12							12	11
68N1	5	5							5	5
68X1	8	8							8	8
68Y1	3	3							3	3
71G1	5	5							5	5

MOS	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Initial	Advance
71L1	494	518							518	494
73C1	102	107							107	102
73D1	13	14							14	13
74B1	96	101							101	96
74C1	26	27							27	26
75B1	141	148			49		49		197	190
75F1	18	19			19		19		38	37
75H1	203	213			144		144		357	347
77F1	389	408			839		839		1247	1228
77L1	23	24			22		22		46	45
77W1	108	113			223		223		336	331
88H1	141	148			191		191		339	332
88K1	22	23			19		19		42	41
88L1	30	32							32	30
88M1	1649	1731							1731	1649
88N1	343	360							360	343
88P1	10	11							11	10
88T1	11	12							12	11
88U1	11	12							12	11
91A1	32	34							34	32
91D1	132	139							139	132
91E1	134	141							141	134
91G1	64	67							67	64
91H1	20	21							21	20
91J1	132	139							139	132
91K1	135	142							142	135
91M1	186	195							195	186
91P1	72	76							76	72
91Q1	28	29							29	28
91R1	35	37							37	35
91S1	51	54							54	51
91T1	12	13							13	12
91V1	5	5							5	5
91W1	1236	1298							1298	1236
91X1	92	97							97	92
92A1	854	897							897	854
92G1	459	482							482	459
92M1	63	66							66	63
92R1	90	94							94	90
92S1	297	312							312	297
92Y1	381	400							400	381
93C1	1	1							1	1
93P1	22	23							23	22
95B1	202	212	501	477		123		13	836	692
95C1	8	8	26	25					35	33

MOS	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Initial	Advance
96B1	80	84							84	80
96D1	35	37							37	35
96R1	1	1							1	1
97B1	39	41							41	39
97E1	29	30							30	29
97L1	35	37							37	35
98G1	5	5							5	5
98J1	15	16							16	15
Grand Total	12632	13264	1793	1698	3500	443	2043	287	19000	16660

Table 10. MOS Output by Type (*penunder* = 2)

2. Weekly Output by Type

Start Week	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Grand Total
w30Sep02	24	383	68	39					515
w07Oct02	494	418	81	127			111		1230
w14Oct02	504	223	24				8		758
w21Oct02	369		3				7		380
w28Oct02	316	181		59			13		570
w04Nov02	254	347	55	89			13		757
w11Nov02	193	234	12						438
w18Nov02	288	201	114	7			8		619
w25Nov02	150	269		64			26		508
w02Dec02	276			75			19		370
w09Dec02	301			22			50		373
w16Dec02	34			3					37
w06Jan03	449	47	16				10		522
w13Jan03	170	612		51			53		886
w20Jan03	323	345	102	11			11		792
w27Jan03	219	126	52	106			60		563
w03Feb03	185	320	76				59		640
w10Feb03	224	338	13				45		620
w17Feb03	434	405							839
w24Feb03	73	8	40						120
w03Mar03	22	227		15			8		272
w10Mar03	44	324	58				5		431
w17Mar03	574	176	166	95					1011
w24Mar03	322	248		48			15		633
w31Mar03	118	187		71			80		456
w07Apr03	300	308	99	12			8		727
w14Apr03	314	142					53		509
w21Apr03	379	437	28	37			50	20	951
w28Apr03	7	275					164		446
w05May03	212	192	38	54			45	15	556
w12May03	301	335		155			33		824
w19May03	164	192	5		231	53	107		752
w26May03	231	26	85		269		56		667

Start Week	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Grand Total
w02Jun03	174	428	33	92	269	161	45	20	1222
w09Jun03	286	134	9		676	147	126		1378
w16Jun03	132	260	29	26	759	37	95	24	1363
w23Jun03	406	376	85		596		157		1619
w30Jun03	255	237		35	460		92		1079
w07Jul03	179	288	25			45	71	20	628
w14Jul03	311	268	112	5	80		110	15	901
w21Jul03	179	376	6	79	160		110	15	925
w28Jul03	24	58	46	31			8		166
w04Aug03	398	580	78	8			14	116	1195
w11Aug03	125	122	1	27			50		326
w18Aug03	242	357		79			9		688
w25Aug03	350	406	52				14		821
w01Sep03	222	306	3	23			1		556
w08Sep03	269	419	56	104			8	20	877
w15Sep03	251	672	123	6			6		1057
w22Sep03	318	451		43			11	21	845
w29Sep03	244								244
Grand Total	12632	13264	1793	1698	3500	443	2043	287	35660

Table 11. Weekly Output by Type (*penunder* = 2)

3. Monthly Output by Type

month	AIT	BCT	OSUT1	OSUT2	SP1	SP1o	SP2	SP2o	Grand Total
mOct02	1391	1024	176	166	0	0	126	0	2883
mNov02	1201	1231	181	219	0	0	60	0	2892
mDec02	610	0	0	100	0	0	69	0	779
mJan03	1161	1130	170	168	0	0	134	0	2763
mFeb03	915	1071	129	0	0	0	104	0	2219
mMar03	962	975	225	158	0	0	28	0	2348
mApr03	1112	1073	127	120	0	0	191	20	2643
mMay03	914	1019	128	209	500	53	405	15	3243
mJun03	998	1199	156	118	2300	345	422	45	5583
mJul03	924	1169	143	119	700	45	383	50	3533
mAug03	1139	1523	177	145	0	0	95	116	3195
mSep03	1304	1849	182	176	0	0	26	41	3578
Grand Total	12631	13263	1794	1698	3500	443	2043	287	35659

Table 12. Monthly output by Type (*penunder* = 2)

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B: USER'S GUIDE

A. COLLECT DATA FILES

Below is a list of data files from ATRRS and TAPDB-R. We provide an example of each file received and the source. Where possible, we recommend adjustments to the files to simplify data manipulations.

1. ATRRS Data Files.

Several agencies are able to access ATRRS data. Some data is accessible through the Internet. Personnel from ODCSPER and OCAR have special access through intranet servers. These personnel may have special training and access to information that enables them to query the system and provide data files that we can easily input into our model. We should pursue better input files where possible.

a. FY Training Schedule

Mr. Alan Craig of ODCSPER, MPT is a source for the FY 03 schedule from ATRRS. The picture below is a small sample of the file and its layout.

ENL MOS	SCHOOL	CRS	P	CLS	REPORT DATE	START DATE	END DATE	2003
------	--------------------------------	---------------------------	-	-----	---------	-------	-----------	-------
00B1	807 MANSCEN ATC, FT LEONARD W	A-433-00B10	1	001	021004	021007	021025	12
				002	030207	030210	030228	12
				003	030502	030505	030522	13
*TOTAL	EMOS 00B1							37
02B1	514 NAVY SCH OF MUSIC, VA	450-02B10 (A-450-0010)		010	021004	021007	030403	1
				020	021018	021021	030416	2
				030	021101	021104	030430	1
				040	021115	021118	030513	2
				050	021129	021202	030527	1
				070	030117	030121	030702	1
				080	030207	030210	030723	1
				100	030314	030317	030826	2
				120	030404	030407	030917	1
				130	030425	030428	031008	2
				140	030509	030512	031023	1
				150	030523	030527	031106	2
				160	030613	030616	031128	1
				180	030801	030804	040129	2
				190	030905	030908	040304	1
*TOTAL	EMOS 02B1							21
02C1	514 NAVY SCH OF MUSIC, VA	450-02C10 (A-450-0010)		010	021004	021007	030403	1
				030	021101	021104	030430	1

Available seats in the class

Table 13. FY 03 Schedule
ODCSPER downloads this file from ATRRS for input into the model.

This file provides the schedule for AIT, OSUT, SP1o and SP2o training seats. You must assign training seats to a week based on the start date. The resulting data is included in the *seatstwns* input file for the GAMS model. Steps include:

(1) Delete all blank rows and "Total" rows. You may use a macro with an "if" statement to delete these rows.

(2) Assign a start week and start month based on the start date above using a lookup function that references a file with the start week and associated month for the stipulated FY. For easy reference, you may copy the start week and associated month worksheet into a workbook with the training schedule.

(3) Explicitly assign the MOS for each class using an "if" algorithm.

(4) Explicitly assign the school for each class using an "if" algorithm.

(5) Explicitly assign the course for each class using an "if" algorithm.

(6) Explicitly assign the type of training for each class using an "if" statement (AIT, OSUT, SP1o, SP2o).

(7) Concatenate explicit assignments and paste the results into the *seatstwns* file.

(8) Derive OSUT1 and OSUT2 seats by simply labeling OSUT seats as OSUT1 and OSUT2 separately.

b. Basic Combat Training Files

Access ATRRS and run a routine schedule report by BCT site. Copy and paste the data into a spreadsheet. The spreadsheet requires a lot of hand manipulation due to labeling. A macro may reduce this time from several hours to minutes. The data available does not reflect male and female allocations or any designation of SP1 seats. Individuals with more knowledge and access may query ATRRS to download a data file with BCT and possibly SP1 information. Information by site includes the start week, each component's slice and the total seats for that week. Collect the total seats by week by school.

Use the BCT totals to derive available seats for SP1 during the summer based on ODCSPER and OCAR policy for SP1. Subtract SP1 seats from the total BCT seats to determine BCT seats for the summer period. Use the results as input into the *seatstws* file.

Now we assign artificial seats by MOS for each week that we have available BCT and SP1 training.

c. Historical Training Files

Mrs. Kathy Aceto of OCAR, Personnel Division is a source for historical IET files from ATRRS for the Army Reserve by FY. The following picture is a sample of the file.

SSN	FY	MOS	START DATE	END DATE	INPUT	OUTPUT	QS	CRS #	SELECT CODE
489964823	2001	93P1	20001106	20001219	I	G	MJ	556-93P10	ECEDE4BL
551913195	2001	93P1	20010108	20010220	I	G	MJ	556-93P10	ECEDE4BL
359720420	2001	93P1	20010205	20010319	I	G	MJ	556-93P10	ECEDE4BL
453798639	2001	93P1	20010205	20010319	I	G	MJ	556-93P10	ECEDE4BL
301765654	2001	93P1	20010212	20010326	I	Z	MK	556-93P10	ECEDE4BL
336709181	2001	93P1	20010409	20010518	I	G	MK	556-93P10	ECEDE4BL
615017576	2001	93P1	20010604	20010716	I	G	MJ	556-93P10	ECEDE4BL
556975430	2001	93P1	20010611	20010723	I	G	MJ	556-93P10	ECEDE4BL
604268146	2001	93P1	20010611	20010723	I	G	MJ	556-93P10	ECEDE4BL
315945293	2001	93P1	20010306	20010416	I	G	MJ	556-93P10	ECEDE4BL
566650812	2001	93P1	20010402	20010511	I	G	MK	556-93P10	ECEDE4BL
4826422	2001	51B1	20001002	20001122	I	G	MJ	A-710-0033	ECEDE4BL
283787190	2001	51B1	20001002	20001122	I	G	MJ	A-710-0033	ECEDE4BL
378042302	2001	51B1	20001002	20001122	I	G	MJ	A-710-0033	ECEDE4BL
627057821	2001	51B1	20001002	20001122	I	G	MJ	A-710-0033	ECEDE4BL

Table 14. IET Historical Training File
Use the select code to determine the type of training each individual attended.
Start dates are matched with start weeks for the appropriate FY.

This file provides historical starts by Social Security Number for both initial and advance training for an individual. We manipulate this data to provide the number of trainees by type by week by MOS. If necessary, we can determine gender. Steps include:

(1) Assign a start week and start month based on the start date above using a lookup function that references a file with the start week and associated month for the stipulated FY.

(2) Assign a type training based on the select code and course number using an "if" algorithm.

(3) Sum all starts by training type by start week by MOS.

(4) Match the ordinal location of the weeks for each FY and calculate the average number of starts by type by start week by MOS. Paste results into the input file *goaltmn*. Derive input for the *goaltm* file by summing results by type and start week.

d. SMDR Requirements File

Mrs. Kathy Aceto of OCAR, Personnel Division is a source for the ARPRINT files from ATRRS for the Army Reserve SMDR requirements by FY. We need a different file that works as a better input file. The following picture is a sample of the file.

1(SUMR6) R	TE: 05 APR 2002		QUOTA M	NAGEMENT SYSTE	QMS)			PAGE: 1
			ALL CLA	SSES FOR FY: 2003				
QUOTA	SOURCES: MJ							
0SCHOOL:011	NUMBER:556-93P1	0	PHASE:	TITLE:AVIATION	OPERATI(	SPECIALIST		
0 CLASS	START-DATE	END-DATE	ALLOC	RESERV	WAIT	AVAIL	INPUT	GRADS
-----	----------	--------	-----	------	----	-----	-----	-----
12	10/2/2003	3/4/2003	1	0	0	1	0	0
16	31/03/2003	21/05/2003	1	0	0	1	0	0
22	16/06/2003	7/8/2003	1	0	0	1	0	0
			3					
0SCHOOL:061	NUMBER:121-35M1	0	PHASE:	2 TITLE:RADAR RE	PAIRER			
0 CLASS	START-DATE	END-DATE	ALLOC	RESERV	WAIT	AVAIL	INPUT	GRADS
-----	----------	--------	-----	------	----	-----	-----	-----
2	3/2/2003	26/09/2003	1	0	0	1	0	0
3	24/02/2003	17/10/2003	1	0	0	1	0	0
4	24/03/2003	18/11/2003	1	0	0	1	0	0
			3					
0SCHOOL:071	NUMBER:2E-SI5P/	SQI7/011-S	PHASE:	TITLE:AIRBORNE				
0 CLASS	START-DATE	END-DATE	ALLOC	RESERV	WAIT	AVAIL	INPUT	GRADS
-----	----------	--------	-----	------	----	-----	-----	-----
1	7/10/2002	25/10/2002	3	0	0	3	0	0
2	15/10/2002	1/11/2002	3	0	0	3	0	0
3	21/10/2002	8/11/2002	3	0	0	3	0	0
4	28/10/2002	15/11/2002	4	0	0	4	0	0
5	4/11/2002	22/11/2002	3	0	0	3	0	0
6	12/11/2002	29/11/2002	4	0	0	4	0	0

Table 15. ARPRINT Data File

We extract SMDR data for the fiscal year by MOS from this file.

Each file provides the fiscal year requirements for Army Reserve IET by MOS. Each file has one source-gender code. Source-gender codes are MJ = male (standard training and OSUT), MK = female (standard training and OSUT), MN = male (Split Option), and MP = female (Split Option). It reflects the school code and week of

allocated training. We extract the school code, MOS and total number of allocations (SMDR requirement). Steps include:

(1) Create a spreadsheet by MOS with columns for each source-gender code as below:

MOS	MJ	MK	MN	MP	MOSX	Total
11B1	45	9			n11B1	54
11C1			4		n11C1	4
11H1	4		2		n11H1	6
12B1	400		230		n12B1	630
12C1	80	8	18	15	n12C1	121
13F1	1				n13F1	1
19K1	3				n19K1	3
27D1	32	34	8	2	n27D1	76
31C1		3			n31C1	3
31F1	18	9			n31F1	27

Table 16. SMDR Data File
We create this spreadsheet from the ARPRINT files and sum inputs to derive SMDR requirements by MOS for the FY.

(2) Transcribe data from the ARPRINT file to the SMDR file. You may write a macro that extracts MOS and totals for each MOS from each ARPRINT file into the SMDR file under the appropriate column.

(3) Sum total by MOS and assign an appropriate MOS label that the ARTSAM model identifies.

(4) Delete MOS that are not within the scope of IET training or are no longer valid.

(5) Copy and paste MOSX and Total results into the *MOS* input data file for the model. Do not copy headers into the data file or use "$ONTEXT and $OFFTEXT above and below the header in the first column.

2. TAPDB-R Data Files

Personnel from OCAR, Personnel Division have special training and access to TAPDB-R. We should pursue special queries that are better suited for input into the model.

a. Personnel Fill and DMOSQ File

The Strength Manager of OCAR, Personnel Division is the source of historical personnel fill, DMOSQ fill and personnel attrition data files. Personnel fill and DMOSQ is in the same file while personnel attrition is in a separate file. The picture below is a small sample of the personnel fill and DMOSQ file.

Grade	DMOS/DA	MOS Desc	MPC	Reqd	Auth	Asgn	DQual
E1	11B	Infantryman	E	0	0	114	28
E1	11C	Indirect Fire Infantryman	E	0	0	6	1
E1	11H	Heavy Antiarmor Weapons Infantryman	E	0	0	5	0
E1	11M	Fighting Vehicle Infantryman	E	0	0	2	0
E1	12B	Combat Engineer	E	0	0	242	67
E1	12C	Bridge Crewman	E	0	0	76	26
E2	11B	Infantryman	E	0	0	94	58
E2	11C	Indirect Fire Infantryman	E	0	0	9	4
E2	11H	Heavy Antiarmor Weapons Infantryman	E	0	0	2	1
E2	11M	Fighting Vehicle Infantryman	E	0	0	6	3
E2	12B	Combat Engineer	E	0	0	190	129
E2	12C	Bridge Crewman	E	0	0	56	39
E3	11B	Infantryman	E	137	135	178	98
E3	11C	Indirect Fire Infantryman	E	62	62	13	5
E3	11H	Heavy Antiarmor Weapons Infantryman	E	31	31	11	6
E3	11M	Fighting Vehicle Infantryman	E	148	148	16	9
E3	12B	Combat Engineer	E	875	805	441	344
E3	12C	Bridge Crewman	E	175	175	128	106
E4	11B	Infantryman	E	237	236	645	358
E4	11C	Indirect Fire Infantryman	E	76	76	41	23
E4	11H	Heavy Antiarmor Weapons Infantryman	E	20	20	33	22
E4	11M	Fighting Vehicle Infantryman	E	385	385	87	46
E4	12B	Combat Engineer	E	1,170	1,095	678	573
E4	12C	Bridge Crewman	E	234	234	213	147

Table 17. Personnel Fill and DMOSQ File
The file has the personnel status for each grade. We must consolidate E-1 through E-4 statistics.

Together, these file form the basis for calculating the *pengoal*$_n$ for each MOS. Steps include:

(1) Consolidate E-1 through E-4 statistics using a lookup function.

(2) Calculate percentages for required personnel fill and DMOSQ personnel fill (Asgn/Req and DMOSQ/Reg respectively).

(3) Match MOS attrition data to the results above using a lookup function that references the attrition file. For easy reference, you may copy the attrition worksheet into a workbook with the personnel and DMOSQ fill data. A sample of the attrition worksheet is below. Some columns in the original worksheet are not shown.

(4) Use an "if" statement to calculate the personnel fill and DMOSQ fill portion of the $pengoal_n$ penalty as shown in Table 2. MOS Penalty Input.

(5) An Army Reserve Priority MOS file is not available at this time. You would match the MOS readiness priority using a lookup function and include this value in calculation of $pengoal_n$.

(6) After calculating MOS penalties, paste results into the "mospen" file.

b. Personnel Attrition Data File

Duty	1995			1996			1997			1998			1999			2000			95-00 Att
Skill	Auth	AveAsgn	Loss	Auth	AveAsgn	Loss	Auth	AveAsgn	Loss	Auth	AveAsgn	Loss	Auth	AveAsgn	Loss	Auth	AveAsgn	Loss	Rate
11B	14,327	9,679	3,500	9,048	7,640	2,913	7,400	6,229	1,809	5,966	5,968	1,886	5,923	6,610	1,822	4,170	10,871	10,686	48%
11C	579	401	197	217	183	121	187	125	52	141	115	38	138	120	38	136	170	67	46%
11H	601	368	183	253	175	90	215	139	45	167	125	35	167	132	33	167	156	61	41%
11M	119	174	92	146	121	68	66	34	33	3	18	12	0	49	37	15	177	127	64%
11Z	161	136	36	122	121	31	100	84	21	82	84	10	76	74	13	49	96	31	24%
12B	5,089	4,603	1,885	3,936	3,870	1,401	3,601	3,708	1,339	3,848	3,356	1,113	3,782	3,005	909	3,767	2,745	745	35%
12C	1,093	751	282	985	730	338	841	648	279	749	554	202	738	506	160	671	519	131	38%
13B	2,676	1,694	853	1,167	844	473	368	429	203	449	391	106	450	432	140	451	538	272	47%
13F	276	120	53	126	64	43	39	41	21	28	33	16	27	35	23	25	79	48	55%

Table 18. Skill Level 1 Attrition Data File

We use the Duty Skill column in a lookup function that matches an MOS in the Personnel Fill and DMOSQ file. We calculate and return the value of the "95-00 Att Rate" column.

B. CREATE DATA FILES

We created several files to include as input files into the ARTSAM model. We save these file in a "dat" format and refer to them using an include statement within the model. Several of these files were the result of data received from ATRRS and TAPDB-R. We provide a sample format and purpose of each file below.

1. Original Data Files

We create original data files for direct input into the model. We derive these files from calendars and knowledge of the problem. You must change these files in accordance with the planning horizon under consideration.

a. Planning Weeks

This file lists the date of the first Monday of each week in the planning horizon except for those Mondays before Christmas and New Year's Day. We place a "w" in front of these dates to signify a start week for the index "w" in the model. A sample of the *planweek* file is below.

```
w30Sep02
 w07Oct02
 w14Oct02
 w21Oct02
 w28Oct02
 w04Nov02
 w11Nov02
 w18Nov02
```

Table 19. Planning Weeks in the Horizon.

b. Planning Months

This file lists the months of the fiscal year we are considering as the planning horizon. We place an "m" in front of each month to signify a start month for the index "m" in the model. A sample of the *planmonth* file is below.

```
mOct02
mNov02
mDec02
mJan03
mFeb03
```

Table 20. Planning Month in the Horizon

c. Weeks to Months Pairing

This file lists the start weeks to start month pairings for the planning horizon. To create this file, we determine the pairing of week to months and concatenate the weeks to month pairings with a dot between the indices to create the "weeksinm(w,m)" set in the model. A sample of the *weekmonth* file is below.

w30Sep02.mOct02
w07Oct02.mOct02
w14Oct02.mOct02
w21Oct02.mOct02
w28Oct02.mNov02
w04Nov02.mNov02
w11Nov02.mNov02
w18Nov02.mNov02
w25Nov02.mNov02
w02Dec02.mDec02

Table 21. Paired Weeks to Months for Planning Horizon

d. Military Occupational Specialties (MOS)

This file lists all the MOS that are in the goal files, the MOS penalty file, and historical starts files. We validate MOS by reviewing the *Enlisted MOS Structure* file that is on the ODCSPER intranet. We place an n in front of each MOS to signify an MOS for the index "n". A sample of the *MOS* file is below.

n00B1
n02B1
n02C1
n02D1
n02E1
n02F1
n02G1
n02H1
n02J1

Table 22. MOS

e. Schools

This file lists all the schools that are in the goal files and historical starts files. We validate schools by reviewing the course files that are in the various files from ATRRS. We place an s in front of each school code to signify a school for the index "s". A sample of the *school* file is below.

s011
s061
s081
s091
s093
s101
s113
s171
s191
s215

Table 23. Schools

f. Hold Weeks in the Planning Horizon

This file lists the minimum and maximum number of weeks to hold a trainee between BCT and AIT or OSUT1 and OSUT2. The maximum number of hold weeks between OSUT is normally zero with the exception of the Christmas holiday period. We derive this file by concatenating each start week in the planning horizon with AIT and OSUT2. We stipulate minimums and maximums for each week and type training. This matrix creates the "holdwks(w,tp,*)" set within the model. A sample of the "holdweek" matrix is below.

	mn	mx
w30Sep02.AIT	0	3
w07Oct02.AIT	0	3
w14Oct02.AIT	0	3
w21Oct02.AIT	0	3
w28Oct02.AIT	0	3
w04Nov02.AIT	0	3
w11Nov02.AIT	0	3
w18Nov02.AIT	0	3
w25Nov02.AIT	0	3
w02Dec02.AIT	0	3
w09Dec02.AIT	0	3

Table 24. Hold Week Matrix

g. Training Attrition by School

This file lists the training attrition by school. Mr. Alan Craig gathered these statistics from ATRRS. On average, school with only males experience 6% attrition and coed schools experience 7% attrition. We used statistics to stipulate "attrit(s)" for each school. A sample of the *tngattrit* file is below.

s011	0.07
s061	0.07
s081	0.07
s091	0.07
s093	0.07
s101	0.07

Table 25. School Training Attrition Rates

2. ATRRS and TAPDB-R Input Files

a. Historical Starts by Type, Month and MOS

This file lists the historical starts calculated from the historical starts files from paragraph A.1.c above. These starts become goals within the model and affect results by MOS and type for each month. We only include AIT, OSUT, SP2, SP1o and SP2o because BCT and SP1 are not MOS sensitive training events. A sample of the *goaltmn* file is below.

AIT.mApr03.n11B1	1
AIT.mApr03.n11X1	1
AIT.mApr03.n19D1	1
OSUT1.mApr03.n11B1	3
OSUT1.mApr03.n11H1	1
OSUT1.mApr03.n12B1	15
SP1o.mJun03.n11C1	1
SP1o.mJun03.n12B1	68
SP1o.mJun03.n12C1	25
SP2.mJul03.n11B1	4
SP2.mJul03.n11H1	1
SP2.mJul03.n11M1	1
SP2o.mJun03.n11H1	3
SP2o.mJun03.n12B1	58
SP2o.mJun03.n12C1	15

Table 26. Historical Goals by Type by Month by MOS

b. Historical Starts by Type, Month

This file lists the historical starts calculated from the historical starts files from paragraph A.1.c above. These starts become goals within the model and affect results by type for each month. We only include BCT and SP1 because the other training types are MOS sensitive training events. Goals for SP1 in this file are actually policy stipulated and not history. A sample of the *goaltm* file is below.

BCT.mMay03	727
BCT.mNov02	1012
BCT.mOct02	728
BCT.mSep03	1269
SP1.mJul03	700
SP1.mJun03	2300
SP1.mMay03	500

Table 27. Historical Goals by Type by Month

c. Input to Training by Month

This file lists the monthly input to training goals for the planning horizon. Training manager within ODCSPER and OCAR set these policies based on training seat funding level for the fiscal year. In past years, they included these numbers in mission letters to USAREC. We derived these number based on FY 03 funded seats and historical starts for the past five years. We took the average historical initial starts for each month and divided by the average historical total for the year. We multiplied these ratios by 19,000 (FY 03 funded seats) and rounded down to the nearest hundred for the given month. A sample of the *goalm* file is below.

mOct02	1200
mNov02	1300
mDec02	0
mJan03	1300
mFeb03	1200

Table 28. Input to Training Goals by Month

d. MOS Goals

This file lists the yearly MOS goals for the planning horizon. We determined these requirements from the SMDR file mentioned above in paragraph A.1.d. A sample of the *goaln* file is below.

n11B1	54
n11C1	4
n11H1	6
n12B1	630
n12C1	121
n13F1	1
n19K1	3
n27D1	76

Table 29. SMDR MOS Goals

e. *Available Seats by Type by Week by School*

This file lists the available seats in ATRRS by week by school for BCT training type. We derive these seats from the files from paragraph A.1.b above. A sample of the *seatstws* file is below.

BCT.w07Oct02.s804	220
BCT.w14Oct02.s804	220
BCT.w28Oct02.s804	220
BCT.w11Nov02.s804	220
BCT.w25Nov02.s804	220
BCT.w06Jan03.s804	220

Table 30. Available Seats by Type by Week by School

f. *Available Seats by Type by Week by MOS by School*

This file lists the available seats in ATRRS by type by week by MOS by school for all training types. We derive these seats from the files from paragraph A.1.a above. A sample of the *seatstwns* file is below.

AIT.w07Oct02.n96B1.s301	90
AIT.w07Oct02.n96U1.s301	20
BCT.w08Sep03.n96R1.s804	400
BCT.w08Sep03.n96R1.s805	400
BCT.w08Sep03.n96R1.s807	400
SP1.w26May03.n67V1.s804	200
SP1.w26May03.n67V1.s807	200
SP1.w26May03.n67V1.s809	200
SP2o.w22Sep03.n12B1.s807	50
SP2o.w22Sep03.n12C1.s807	9
SP2o.w23Jun03.n63A1.s804	12

Table 31. Available Seats by Type by Week by MOS by School

C. IMPLEMENTING USAR-TSAM

After collecting data and preparing input files, we manipulate certain parameters to obtain reasonable results. The user must define a few parameters based on limitations set outside of the model. These parameter include the Army Reserve maximum fraction ($usar\_frac\_max_{t,w,n}$) of each type by MOS and week of starts, the maximum number of allowable starts (*nogoal*) for MOS with a zero goal for the planning horizon, and the various penalties for violating goals in the objective function.

The user must determine if all elements of the objective function are necessary. Since redundancy exists in the objective function, the user may decide to eliminate goals that are not important. The user may change the objective function to minimize other measures such as the number and length of time trainees are held between training in the planning horizon.

1. Changing Parameter Values

These steps describe how to change parameter values in ARTSAM using the GAMS IDE software. See chapter 2 or the model code for parameter definitions.

a. Opening the TSAM.GMS File.

(1) Open the GAMS software using an IDE.

(2) Retrieve the project. Go to the pull down menu and select: file, project, open project. If a project does not exist for the ARTSAM model and you are running this model for the first time, you may select: file, project, new project and give it a name.

(3) Retrieve the ARTSAM model. Go to the pull down menu and select: file, open and select TSAM.gms from the appropriate directory.

b. Changing Parameters and Indices in the GAMS Code

(1) The user must change the following parameters and indices within the model code:

t	tm(t)	tp(t)	pair(tm,tp)
h	y	holdwks(w,tp,*)	weeks(tm)
usarfracmx(t,w)	usarfracmax(t,w,n)	fymaxgoal	nogoal
nopen	penunder	penfymaxgoal.	

(2) Scroll down to the parameter and type in the new value. An example of the code follows:

```
SCALARS

fymaxgoal       maximum number of funded USAR starts planning horizon [starts]
 / 19000 /

nogoal          maximum number of starts allowable for MOS with zero goal
 / 10 /

nopen           percentage of goal excess slack allowed without penalty
 / 0.0 /

penunder        penalty per unit violation under the goal
 / 5.0 /

penfymaxgoal    {penalty to exceed fymaxgoal [$/initial_start] }
 / 10.0 /

 Change penfymaxgoal by highlighting and typing the new value
```

Figure 16. GAMS Code Example

c. Changing Parameters and Indices Within $Include Files

Open the appropriate data file using Excel or some other data manipulation software. To open a data file in Excel, follow these instructions.

(1) Choose file, open and change the "files of type" to all.

(2) Select the file name from the appropriate directory.

(3) A text import window will come up. Choose "delimited " and press "next".

(4) For delimiters choose "tab" and press "next".

(5) Press "finish".

(6) The file will display for you to make changes as necessary.

(7) After making changes, press “save”, “yes”, “yes” (Do not attempt to add sheets to the file).

2. Changing the Objective Function

Users may change the objective function or develop a sub-problem with a secondary objective function that solves within limits of the first solution.

a. Eliminating Goals

The user may eliminate some of the current goals by deleting or skipping specific lines of code. We use the following code as an example of deleting or skipping the code.

Highlight and delete

```
*-----------OBJECTIVE FUNCTION------------------------------------
 OBJ..                                                  {11}
   Z =E= SUM((t,m,n)$(tmn(t,m,n)>0 and goaltmn(t,m,n)>0),
                   penunder*UGOALtmn(t,m,n)+OGOALtmn(t,m,n))
       +SUM((t,m  )$(goaltm (t,m  )>0),
                   penunder*UGOALtm (t,m  )+OGOALtm (t,m  ))
       +SUM((  m  )$(goalm  (  m  )>0),
                   penunder*UGOALm  (  m  )+OGOALm  (  m  ))
       +SUM((    n)$(goaln  (    n)>0),
                   pengoaln(n)*(penunder*UGOALn  (    n)+OGOALn  (    n)))
       +penfymaxgoal* OGOAL
```

Figure 17. Deleting Code (Goals)

(1) To delete the input to training goal, highlight the lines of code pertaining to input to training and press the delete button.

Use comment * to skip code

```
*-----------OBJECTIVE FUNCTION------------------------------------
 OBJ..                                                  {11}
   Z =E= SUM((t,m,n)$(tmn(t,m,n)>0 and goaltmn(t,m,n)>0),
                   penunder*UGOALtmn(t,m,n)+OGOALtmn(t,m,n))
*      +SUM((t,m  )$(goaltm (t,m  )>0),
*                  penunder*UGOALtm (t,m  )+OGOALtm (t,m  ))
       +SUM((  m  )$(goalm  (  m  )>0),
                   penunder*UGOALm  (  m  )+OGOALm  (  m  ))
       +SUM((    n)$(goaln  (    n)>0),
                   pengoaln(n)*(penunder*UGOALn  (    n)+OGOALn  (    n)))
       +penfymaxgoal* OGOAL
```

Figure 18. Ignoring Code on a Line (Goals)

(2) Use the asterisk (*) as a command to ignore all code on a particular line. Place the asterisk (*) to the far left of the line you are skipping.

b. Adding Goals

Users may add goals to the objective function such as minimizing the number of hold weeks.

Add an Equation to minimize the number of holds

```
*-----------OBJECTIVE FUNCTION-----------------------------------
 OBJ..                                          {11}
  Z =E= SUM((t,m,n)$(tmn(t,m,n)>0 and goaltmn(t,m,n)>0),
               penunder*UGOALtmn(t,m,n)+OGOALtmn(t,m,n))
     +SUM((t,m  )$(goaltm (t,m  )>0),
               penunder*UGOALtm (t,m  )+OGOALtm (t,m  ))
     +SUM((  m  )$(goalm  (  m  )>0),
               penunder*UGOALm  (  m  )+OGOALm  (  m  ))
     +SUM((    n)$(goaln  (    n)>0),
               pengoaln(n)*(penunder*UGOALn  (    n)+OGOALn  (    n)))
     +penfymaxgoal* OGOAL
     +SUM((tp,w,h,n,s), HOLDR(tp,w,h,n,s))
 ;
```

Figure 19. Adding Goals to the Objective Function

(1) Create an equation that measures the parameter of concern based on the current formulation. Make sure the unit value of the equation is penalty*seats.

(2) In this example, the goal for holds is zero; therefore, any hold is a violation. We sum the hold events by advance type by week by number weeks held by MOS by school. Add the equation to minimize the number of holds.

3. Creating a Sub-problem

Another method of adding goals to the objective of the model is to create a sub-problem. The user must make slight changes to the existing program to create a sub-problem. If the unit of measure is different from the current objective values, create a sub-problem. The figure and comments below is an example of how to implement a sub-problem to minimize hold weeks.

```
-----------EQUATIONS-------------------------------------------

EQUATIONS
  twsSEATS(t,w,s  )  {seats available                             }
  ISTARTS(tm,tp,w,n) {initial training starts either start advanced   }
                 {training immediately or hold for later          }
  ASTARTS(tm,tp,w,n) {advanced training starts either come straight   }
                 {from initial training or return from a hold     }
  LIMSTART(tm,tp,n)  {limit minimum tm to tp starts by n paired for planning horizon}
  LIMADVANCE(w,n)    {limit starts for AIT plus SP2 by AIT available seats for each week}
  LIMSP2 (n)         {limit minimum SP2 starts by SP1 starts for planning horizon}
  LIMSP2o(n)         {limit minimum SP2o starts by SP1o starts for planning horizon}
  tmnGOAL(t,m,n)     {stipulate goaltmn(t,m,n)}
  tmGOAL (t,m  )     {stipulate goaltm (t,m  )}
  mGOAL  (  m  )     {stipulate goalm  (  m  )}
  nGOAL  (    n)     {stipulate goaln  (    n)}
  nGOAL2 (    n)     {stipulate max for n with no goal}
  FYGOAL             {stipulate fymaxgoal     }
  OBJ                {penalty for deviation from goals in constraints }
  OBJ2               {penalty for every week a trainee is held between training}
Add
  INITlimit(m) {restrict further solutions to remain close to original monthly totals}

  ;
```

Figure 20. Additional Equations for Sub-problem

(1) Add the objective function for the sub-problem as an equation (Fig 20).

(2) Add any additional constraints needed to limit the change in results for the sub-problem as an equation (Fig 20).

(3) Stipulate the additional constraint (Fig 21).

(4) Stipulate the additional objective function (Fig 21).

(5) Stipulate changes to the model solve statements from the current solve statement (Fig 22) to the new solve statement (Fig 23). Include the desired output after each solve statement for analysis.

```
 FYGOAL$(fymaxgoal>0)..                                {10}
  SUM((tm,w,n)$(twn(tm,w,n)>0),
    SUM(s$(seatstwns(tm,w,n,s)>0),
      STARTR(tm,w,n,s))) =e= fymaxgoal     -UGOAL          +OGOAL=
 ;
INITlimit(m)..
  SUM((tm, w,n,s)$weeksinm(w,m), STARTR(tm,w,n,s))
    =g= 0.95 * SUM((tm,w,n,s)$weeksinm(w,m), STARTR'(tm,w,n,s))
*-----------OBJECTIVE FUNCTION-------------------------------------

 OBJ..                                         {11}
  Z =E= SUM((t,m,n)$(tmn(t,m,n)>0 and goaltmn(t,m,n)>0),
                 penunder*UGOALtmn(t,m,n)+OGOALtmn(t,m,n))
      +SUM((t,m  )$(goaltm (t,m  )>0),
                 penunder*UGOALtm (t,m  )+OGOALtm (t,m  ))
      +SUM((  m  )$(goalm  (  m  )>0),
                 penunder*UGOALm  (  m  )+OGOALm  (  m  ))
      +SUM((    n)$(goaln  (    n)>0),
                 pengoaln(n)*(penunder*UGOALn  (    n)+OGOALn  (    n)))
      +penfymaxgoal* OGOAL
 ;
 OBJ2..
 Z =E= SUM((tp,w,h,n,s), ORD(h) * HOLDR(tp,w,h,n,s))
 ;
```

Figure 21. Stipulating Additional Objective Function and Constraint

```
MODEL schedule /ALL/ ;

 SOLVE schedule USING LP MINIMIZING Z ;
```

Figure 22. Current Solve Statement

```
MODEL schedule /twsSEATS, ISTARTS, ASTARTS, LIMSTART, LIMADVANCE, LIMSP2,
                        LIMSP2o, tmnGOAL, tmGOAL, mGOAL, nGOAL, nGOAL2, OBJ/ ;

 SOLVE schedule USING LP MINIMIZING Z ;
****
*Include desired output here.

LOOP ((tm,w,n,s),
   STARTR*(tp,w,n,s) = STARTR.l(tp,w,n,s)
 );
***
MODEL schedule2 / ALL /;

SOLVE schedule2 USING LP MINIMIZING Z;

*Include desired output here.
```

Figure 23. Adjusted Solve Statement

D. CAPTURING AND ANALYZING RESULTS

We capture results by writing code within the model that tells the solver to output results into a ".csv" file. After the model runs, it will output stipulated data into designated files. We can view these files in Excel or some other data manipulation software that handles "csv" files. We use these files to examine output variables of interest and identify possible shortcomings of the model. Current output files include the following:

Startr.csv – results of the number of starts by type by week by MOS by school. *Startr.csv* has the model's recommendation for the Army Reserve IET schedule. We use this file to conduct detailed analysis of model results versus parameter changes. We can cross-tab the data in Excel and view it in comparison to historical starts and current goals as shown in chapter 3.

Startwk.csv – results of the total number of starts by week. *Startwk.csv* has the model's recommendation for starts at the type and month level. We are able to conduct quick and general analysis when evaluating the basic behavior of the model versus parameter changes. We can cross-tab the data in Excel and view it in comparison to historical starts and current goals as shown in chapter 3.

Startgtm.csv – results of the number of starts by type by month.

Seatvtwns.csv – value of each available unfilled seat by type by week by MOS by school by the number of seats. We need these seats to achieve a goal, but they were not used due to some constraint(s) in the model.

Seatvtws.csv – value of each available unfilled seat by type by week by school by the number of seats (BCT). This file is usually empty since most goal restrictions are MOS related.

Ipairs.csv – tracks the flow of initial starts to monitor whether the model is assigning each BCT and OSUT1 completion as a hold or advance start.

Apairs.csv – tracks the flow of advance starts to monitor whether the model is assigning each trainee from initial training completion or hold to an advance start.

Holdr.csv – results of the number of holds by advance type by week by hold weeks by MOS by school.

Pen.csv – results of the penalty for violating each goal by type by month by MOS.

The figure below is an example of how to create a csv output file from ARTSAM.

```
FILE startrcsv /startr.csv/ ;
 PUT startrcsv ;
 PUT '*t,w,n,s,STARTR' / ;
 LOOP((t,w,n,s)$(STARTR.l(t,w,n,s)>0),
   PUT t.tl:5,',',w.tl:8,',',n.tl:5,',',s.tl:5,',',STARTR.l(t,w,n,s) / ;
 );
 PUTCLOSE startrcsv ;
```

Figure 24. Sample Code for “CSV” File

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF REFERENCES

AR 350-10. 1990, Army Regulation 350-10, Management of Army Individual Training Requirements and Resources, Effective 15 October 1990, Department of the Army.

ATRRS. 2002, Army Training Requirements and Resources System Home Page. Database on-line. Available at http://www.atrrs.army.mil.

GAMS. 1998, General Algebraic Modeling System, Version ug254j. GAMS Development Corp. 1217 Potomac Street, NW, Washington D.C. 20007.

Hall, M. L. 1999, "Optimal Scheduling of Army Initial Entry Training Course", Master's Thesis, Operations Research Department, Naval Postgraduate School, Monterey. June.

TRADOC Regulation 350-6. 2001, Enlisted Initial Entry Training (IET) Policies and Administration. Effective 3 July 2001. US Army Training and Doctrine Command.

USARC Regulation 600-2. 2001, US Army Reserve Personnel Systems, Personnel Accounting, and Commander's Guide to Personnel and Unit Database Management. Effective 1 June 2001. US Army Reserve Command.

Whaley, D. L. 2001, "Scheduling the Recruiting and MOS Training of Enlisted Marines", Master's Thesis, Operation Research Department, Naval Postgraduate School, Monterey, September.

Winkler, J. D, Shanley, M. G., Schank, J., Crowley, J. C., Mattock, M. G., Madison, R., McDonald, L. L., Green, D., Steinberg, P. 1999, "*The Total Army School System: Recommendations for Future Policy*". RAND. On-line Available at http://www.rand.org/publications/ MR/MR955.

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California

3. Colonel Dennis Scott
   Office of the Chief, Army Reserve
   Washington, D.C.

4. Senior Lecturer David Olwell
   Department of Operations Research
   Naval Postgraduate School
   Monterey, California

5. Associate Professor Sam Buttrey
   Department of Operations Research
   Naval Postgraduate School
   Monterey, California

6. Professor Gerald G. Brown
   Department of Operations Research
   Naval Postgraduate School
   Monterey, California

7. Lieutenant Colonel Stewart Goesch
   Office of the Chief, Army Reserve
   Washington, D.C.